DOE/RL-2006-53
Revision 1 REISSUE

Engineering Evaluation and Environmental Analysis Report for the Plutonium Finishing Plant Sub-Grade Structures and Installations

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

United States Department of Energy
P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

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A. M. Hopkins
Fluor Hanford, Inc.

S. L. Charboneau
E. M. Mattlin
Department of Energy - Richland Operations Office

L. Oates
Environmental Quality Management, Inc.

J. A. Teal
Fluor Government Group

A. R. Sherwood
Fluor Hanford, Inc.

D. C. Lini
Science Applications International Corporation

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United States
Department of Energy
P.O. Box 550
Richland, Washington 99352

J. D. Aardal 06/07/2007
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Engineering Evaluation and Environmental Analysis Report for the Plutonium Finishing Plant Sub-Grade Structures and Installations

EXECUTIVE SUMMARY

This report documents an engineering evaluation and environmental analysis of the actions necessary to address the contaminated Plutonium Finishing Plant sub-grade structures (i.e., building slabs, vaults, pipe tunnels, ductwork, and diversion boxes) and installations (i.e., buried pipelines, French drains, injection wells, and known unplanned releases).

In 2002, the U.S. Department of Energy, Richland Operations Office, the U.S. Environmental Protection Agency, and the Washington State Department of Ecology developed *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) milestones for the transition of the Plutonium Finishing Plant facility. The result of the milestone development is documented in *Hanford Federal Facility Agreement and Consent Order* Change Request M-83-00-01-03. Development of the Plutonium Finishing Plant sub-grade engineering evaluation and environmental analysis report supports activities associated with the *Hanford Federal Facility Agreement and Consent Order* Interim Milestone M-083-22 which requires that the U.S. Department of Energy "*perform an evaluation of actions necessary to address below-grade structures or other structures or hazardous substances, dangerous waste or dangerous constituents remaining after completion of M-83-00A*" for the purpose of transitioning the Plutonium Finishing Plant facility from the operations phase to the disposition phase as described in the *Hanford Federal Facility Agreement and Consent Order* Action Plan Section 8. This engineering evaluation/environmental analysis has been performed along *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* guidelines to facilitate future remedial investigation feasibility study(ies), final records of decision for the relevant operable units responsible for Central Plateau remedial activities, and subsequent site closure. Following completion of M-83-00A, Plutonium Finishing Plant Facility Transition, the Plutonium Finishing Plant sub-grade structures and installations will be dispositioned consistent with the Central Plateau M-15 final records of decision, and will be included in the M-16 workscope and milestone.

The scope of activities for this engineering evaluation and environmental analysis is to identify the Plutonium Finishing Plant sub-grade items to be evaluated, to determine their potential hazardous substances through process history and available analytical data, to evaluate these hazards and, as necessary, to evaluate the available interim alternatives to reduce the risk associated with the contaminants against criteria of effectiveness, implementability, and cost. This Plutonium Finishing Plant sub-grade engineering evaluation and environmental analysis considered four alternatives for interim action: (1) No Action, (2) Surveillance and Maintenance, (3) Stabilize and Leave in Place, and (4) Remove, Treat and Dispose. Within Alternative 4, the analysis considered three options for the removal of building slabs; Option A would remove all building slabs, Option B would remove only those building slabs with known plutonium inventory, and Option C would not remove any building slabs. Each alternative was evaluated against criteria for effectiveness, implementability, and cost. Each criterion was given equal weight in the analysis process.

The Surveillance & Maintenance alternative (Alternative 2) was determined to be the most efficient approach to address contamination concerns for the Plutonium Finishing Plant sub-grade structures and installations for an interim action until final records of decision determine final remedial actions. The recommendation of this analysis is to perform surveillance and maintenance on the Plutonium Finishing Plant sub-grade items until such time as remedial actions are initiated.

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ATTACHMENTS

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ACRONYMS

ARAR	applicable or relevant and appropriate requirement
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CLUP-EIS	*Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*
D&D	decontamination and decommissioning
DBBP	dibutylbutyl phosphonate
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EE/CA	engineering evaluation/cost analysis
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
HVAC	heating, ventilation, and air conditioning
OU	operable unit
PFP	Plutonium Finishing Plant
PRF	Plutonium Reclamation Facility
RAO	removal action objective
RCRA	*Resource Conservation and Recovery Act of 1976*
RECUPLEX	Recovery of Uranium and Plutonium by Extraction
RG	Rubber Glove
RI/FS	remedial investigation/feasibility study
RL	DOE, Richland Operations Office
RMA	Remote Mechanical "A"
RMC	Remote Mechanical "C"
ROD	record of decision
RTD	remove, treat, and dispose
TBP	tributyl phosphate
TEDF	Treated Effluent Disposal Facility
TSD	treatment, storage, and disposal
S&M	surveillance and maintenance
SHPO	State Historic Preservation Office
UPR	unplanned release
WAC	*Washington Administrative Code*
WIDS	Waste Information Data System

METRIC CONVERSION CHART

Into metric units			Out of metric units		
If you know	Multiply by	To get	If you know	Multiply by	To get
Length			**Length**		
Inches	25.40	millimeters	millimeters	0.03937	inches
Inches	2.54	centimeters	centimeters	0.393701	inches
Feet	0.3048	meters	Meters	3.28084	feet
Yards	0.9144	meters	Meters	1.0936	yards
miles (statute)	1.60934	kilometers	kilometers	0.62137	miles (statute)
Area			**Area**		
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.09290304	square meters	Square meters	10.7639	square feet
square yards	0.8361274	square meters	Square meters	1.19599	square yards
square miles	2.59	square kilometers	square kilometers	0.386102	square miles
Acres	0.404687	hectares	hectares	2.47104	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir)	28.34952	grams	Grams	0.035274	ounces (avoir)
Pounds	0.45359237	kilograms	kilograms	2.204623	pounds (avoir)
tons (short)	0.9071847	Tons (metric)	tons (metric)	1.1023	tons (short)
Volume			**Volume**		
ounces (U.S., liquid)	29.57353	milliliters	milliliters	0.033814	ounces (U.S., liquid)
quarts (U.S., liquid)	0.9463529	liters	Liters	1.0567	quarts (U.S., liquid)
gallons (U.S., liquid)	3.7854	liters	Liters	0.26417	gallons (U.S., liquid)
cubic feet	0.02831685	cubic meters	cubic meters	35.3147	cubic feet
cubic yards	0.7645549	cubic meters	cubic meters	1.308	cubic yards
Temperature			**Temperature**		
Fahrenheit	subtract 32 then multiply by 5/9ths	Celsius	Celsius	multiply by 9/5ths, then add 32	Fahrenheit
Energy			**Energy**		
kilowatt hour	3,412	British thermal unit	British thermal unit	0.000293	kilowatt hour
Kilowatt	0.94782	British thermal unit per second	British thermal unit per second	1.055	kilowatt
Force/Pressure			**Force/Pressure**		
pounds (force) per square inch	6.894757	kilopascals	kilopascals	0.14504	pounds per square inch

06/2001

Source: Engineering Unit Conversions, M. R. Lindeburg, PE., Third Ed., 1993, Professional Publications, Inc., Belmont, California.

ENGINEERING EVALUATION AND ENVIRONMENTAL ANALYSIS REPORT FOR THE PLUTONIUM FINISHING PLANT SUB-GRADE STRUCTURES AND INSTALLATIONS

1.0 INTRODUCTION

This report documents an engineering evaluation and environmental analysis (analysis) of actions necessary to address contaminated sub-grade structures (i.e., building slabs, vaults, pipe tunnels, ductwork, and diversion boxes) and installations (i.e., buried pipelines, French drains, injection wells, and known unplanned releases) at the Hanford Site Plutonium Finishing Plant (PFP).

This analysis has been performed along CERCLA guidelines to facilitate contribution to future remedial investigation/feasibility study (RI/FS) evaluation and subsequently to the final records of decision (ROD) for the relevant operable units responsible for site closure.

This analysis captures available knowledge of processes at PFP that might have contributed to contamination, evaluates the potential hazards associated with PFP sub-grade structures and installations, and evaluates the interim actions available to reduce those hazards. Final remedial action goals for sub-grade structures and installations are planned for inclusion in the scope of decision documents for the relevant operable units (OU), as described in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (DOE/RL-98-28).

This report is organized in the following manner:

- Chapter 1.0 provides the scope of this analysis and summarizes decontamination and decommissioning (D&D) activities at the PFP facility.
- Chapter 2.0 provides relevant background information and describes the structures and installations within the scope of this analysis. Also provided is a description of the nature of known hazardous substances and the risks associated with these substances.
- Chapter 3.0 establishes objectives for the alternatives that will be evaluated.
- Chapter 4.0 identifies the interim action alternatives available to reduce the risk associated with the PFP sub-grade structures and installations.
- Chapter 5.0 analyzes and compares each alternative relative to the criteria of effectiveness, implementability, and cost and each other.
- Chapter 6.0 presents the recommended alternative.
- Attachment 1 lists sites historically associated with the PFP complex and provides a brief rationale for excluding specific sites from the scope of this analysis.

- Attachment 2 illustrates the major process pipelines and the facilities they serviced over the operating life of the PFP.

- Attachment 3 provides information on sensitivity analyses conducted to test cost estimate assumptions and conservatisms in assessing the alternatives.

1.1 PURPOSE

The purpose of the analysis is to identify, document, and evaluate the actions necessary to address the contaminated PFP sub-grade structures and installations. Development of the PFP sub-grade structures and installations engineering evaluation and environmental analysis supports activities associated with the *Hanford Federal Facility Agreement and Consent Order* (HFFACO) (Ecology et al. 1989) Interim Milestone M-083-22 which requires that the U.S. Department of Energy (DOE) "*perform an evaluation of actions necessary to address below-grade structures, or other structures or hazardous substances, dangerous waste or dangerous constituents remaining after completion of M-83-00A*" for the purpose of transitioning the PFP facility from the operations phase to the disposition phase as described in the HFFACO Action Plan Section 8.

The M-083-22 interim milestone was developed and agreed to by the DOE, EPA, and Ecology to create an efficient and cost-effective way to eliminate the bulk of the hazards from PFP by demolishing the facility to a slab-on-grade configuration consistent with CERCLA Action Memoranda and the approved PFP endpoint criteria.

1.2 SCOPE OF ANALYSIS AND RELATIONSHIP TO PFP D&D ACTIVITIES

The scope of the PFP sub-grade structures and installations analysis is to identify the sub-grade items to be evaluated, to determine their hazardous substances through process history and available data, to evaluate these hazards and, as necessary, to evaluate the available interim alternatives to reduce the risks associated with hazardous constituents in, on, beneath or within building slabs, buried pipelines, contaminated soil resulting from spills, and other buried structures and installations associated with PFP chemical processes, waste transfers, and disposal activities, prior to final remedial action. The items addressed by this analysis include assessing interim actions to reduce risks. For example, interim actions may in part address removal of a building slab, but may defer removal of all underlying contaminated soil, if any, to final remediation. Proposed interim actions are discussed in Chapter 4.0. Final remediation will be determined as a result of RI/FS evaluations and ultimately a ROD for the appropriate OU. A complete listing of the structures and installations considered in-scope for this analysis is identified in Table 1-1. If a structure or installation listed in Table 1-1 is later determined to be uncontaminated, that item will be deleted from the scope of the analysis. If other structures or installations at PFP are identified during deactivation activities that are sufficiently similar to the structures and installations addressed by this analysis (i.e., contaminated with hazardous substances that present a threat of release), they will be added to the scope.

Decontamination and decommissioning activities at much of the PFP facility are discussed in three separate EE/CAs. The 232-Z Contaminated Waste Recovery Process Facility and the 241-Z-361 Settling Tank are the subject of the *Engineering Evaluation/Cost Analysis for the Removal of the Contaminated Waste Recovery Process Facility, Building 232-Z* (DOE/RL-2003-29) and *Tank 241-Z-361 Engineering Evaluation/Cost Analysis*

(DOE/RL-2003-52), respectively. The remaining above-grade structures at PFP are addressed in DOE/RL-2004-05, *Engineering Evaluation/Cost Analysis for the Plutonium Finishing Plant Above-Grade Structures*. These EE/CAs and associated Action Memoranda (for the 232-Z and PFP above-grade structures) confirmed a slab-on-grade end point as the preferred alternative for transition of the buildings at PFP. They did not address alternatives for contamination in, on, beneath or within building slabs, other than to require stabilization or cover, as needed, for protection of workers, the public and the environment. This analysis addresses the remaining building slabs, sub-grade ductwork and structures, and buried pipelines associated with these buildings and the 241-Z-361 Settling Tank.

The PFP complex covers approximately 25 acres, more than 60 structures, numerous sub-grade structures and installations, and a wide variety of waste sites and unplanned release sites. Many of these items were the subject of interim removal action analyses and others are within the scope of in-progress and planned final remedial action analyses. The RI/FS activities for the 200-PW-1, 200-PW-3, 200-PW-6, 200-CW-5, and 200-IS-1 OUs are currently in-progress and a proposed plan for those OUs is expected in the near future. Sub-grade structures and installations within the PFP complex have been included in the scope of this analysis through the following screen:

1. Is the structure/installation part of the PFP Complex? If yes, it potentially is within the scope of this analysis. For example, the sub-grade (crib) portion of the 216-Z-9 Facility received waste from processes at PFP, but has been assigned to the Central Plateau Project for remedial action. Therefore, the 216-Z-9 Crib is not included in the scope of this analysis.

2. Is the structure/installation contaminated or potentially contaminated with hazardous substances? If yes, it is potentially included in the scope of this analysis. If not (e.g., building slabs that are not contaminated, electric lines, service and clean water pipelines, telecommunications, cathodic protection, etc.), the structure/installation is excluded from the scope.

3. Is the structure/installation situated in the sub-grade (e.g., contaminated buried pipelines)? If yes, it is potentially within the scope of this analysis.

4. Has the structure/installation previously been or is it currently being evaluated under CERCLA? If yes, it does not belong within the scope of this analysis (e.g., Tank 241-Z-361).

5. Is the structure/installation a contaminated building slabs? If yes, contaminated building slabs, though not buried, are in the scope of this analysis.

These five criteria were applied to identified structures and installations associated with the PFP complex that would be in the scope of this analysis. Attachment 1 lists sites historically associated with the PFP complex and provides a brief rationale for excluding specific sites from the scope of this analysis. Table 1-1 identifies the sub-grade structures and installations remaining after the application of these screening criteria to the sites identified in Attachment 1.

Details for the buried pipelines and other sub-grade structures and installations addressed by this analysis are included in the appropriate discussions found in Chapter 2.0. Attachment 2 illustrates the major process pipelines and the facilities they serviced over the operating life of the PFP.

Disposal facilities outside the scope of this analysis are also described in this document to help assess the hazards associated with related pipelines, but these disposal facilities generally are not within the scope of this analysis. Because these cribs, ditches, French drains, and tile fields are already being managed through an established OU, their remediation will be through other site programs.

Table 1-1. Structures and Installations in Engineering Evaluation and Environmental Analysis Scope[1]. (6 pages)

Structure/ Installation Designation	Description	Comment
Contaminated Building Slabs		
232-Z	Contaminated Waste Recovery Process Facility, including buried ductwork between 232-Z and 291-Z	Building slab and sub-grade ductwork contaminated. Ductwork is filled with concrete.
234-5Z	Plutonium Fabrication Facility, includes below-grade tunnels and pipe trenches	Building slab/tunnels/trenches contaminated.
236-Z	Plutonium Reclamation Facility, including buried ductwork between 236-Z and 291-Z	Building slab and ductwork contaminated.
241-Z	Tank Farm Waste Disposal Building, includes below-grade vault and tanks, pipe trench, and ductwork	Building slab, vault, pipe trench, and ductwork contaminated.
241-ZA	Sample Building	Building slab contaminated.
241-Z-RB (also known as 207-Z)	Retention Basin and valve pit	Retention basin/valve pit contaminated. Retention Basin/valve pit are filled with controlled-density fill.
242-Z	Waste Treatment Facility	Building slab contaminated.
243-Z	Low-Level Waste Treatment Facility	Building slab contaminated.
243-ZA	Low-Level Waste Storage Facility	Building slab contaminated.
2736-Z	Plutonium Storage Building	Building slab contaminated.
2736-ZA	Plutonium Storage Ventilation Structure	Building slab contaminated.
2736-ZB	Plutonium Storage Support Facility	Building slab contaminated.
2904-ZA	Radiation and Flow Monitoring Station	Building slab contaminated.
2904-ZB	Monitoring Building	Building slab contaminated.
291-Z	Exhaust Air Filter Building, includes below-grade fan house, exhaust plenum, and ducting to 291-Z-001	Building slab/below-grade portions contaminated. (Assume structure not filled by DOE/RL-2004-05 activities.)
291-Z-001	Stack, includes below-grade portion of stack structure	Stack slab/structure contaminated. (Assume structure not filled by DOE/RL-2004-05 activities.)
Contaminated French Drains and Injection Wells		
216-Z-13	French Drain, east of 291-Z	Also identified as an injection well at

Table 1-1. Structures and Installations in Engineering Evaluation and Environmental Analysis Scope[1]. (6 pages)

Structure/ Installation Designation	Description	Comment
		miscellaneous stream number 261.
216-Z-14	French Drain, west of 291-Z	Also identified as an injection well at miscellaneous stream number 262.
216-Z-15	French Drain, north of 291-Z	Also identified as an injection well at miscellaneous stream number 263.
Contaminated Injection Wells		
Miscellaneous Stream Number 232	241-Z Building – Eyewash/safety shower. Location: East side of 241-Z	
Miscellaneous Stream Number 234	241-Z Building – Main steam line trap	
Miscellaneous Stream Number 235	241-Z Building – Waste tank steam supply trap. Five steam traps discharge to the same injection well.	
Unplanned Releases		
Undocumented UPR @ 241-Z Trench	In February 1969, the D-6 waste pipeline from the 234-5 and 236-Z Buildings to the 241-Z Sump failed in concrete pipe trench resulting in a release to soil of an estimated 11,356 L (3,000 gal) of process waste.	As of this writing, this release has not been recorded in the Waste Information Data System.
Undocumented UPR @ beneath 234-5Z	Potential releases may have occurred from direct buried piping or from pipe trenches located beneath the 234-5Z building slab and may have leaked into the soils beneath the slab.	As of this writing, this release has not been recorded in the Waste Information Data System.
UPR-200-W-23	In June 1953, a fire in a waste box contaminated approximately 28 m^2 (300 ft^2) of ground. Plutonium contamination resulted in readings up to 10,000 dpm. This release is located near the south wall of 234-5Z, approximately 61 m (200 ft) north of the 291-Z stack	A 1999 walkdown could not locate this site. The contaminated area was covered with blacktop and posted.
UPR-200-W-103	In April, 1971, the line from the 234-5Z complex to the 216-Z-18 crib broke near the southeast corner of the 236-Z Building. The release contained approximately 10 grams (0.35 oz) of plutonium with gross alpha contamination >6,000,000 dpm. This release is located 1.8 m (6 ft) south and 3.7 m (12 ft) west of the SW corner of the 236-Z building.	An area measuring 7.6 m (25 ft) by 1.8 m (6 ft) by 2.1 m (7 ft) deep was excavated around the leak. Approximately 100 208 L (55 gal) barrels of contaminated soil was removed and buried. A considerable amount of contaminated soil remained when the excavation was backfilled. The site is posted with underground radioactive material area warning signs.

Table 1-1. Structures and Installations in Engineering Evaluation and Environmental Analysis Scope[1]. (6 pages)

Pipeline Designation	Route	Material	Comments
Contaminated Buried Pipelines & Diversion Boxes.[2]			
Diversion Box No. 1 (200-W-58)	N/A	Concrete	Includes adjacent drain field. (Assume filled with controlled-density fill by DOE/RL-2004-05 activities.)
Diversion Box No. 2 (200-W-59)	N/A	Concrete	Includes adjacent drain field. (Assume filled with controlled-density fill by DOE/RL-2004-05 activities.)
½"-M9	241-Z east wall to 241-ZA	SST	Pipeline has a 15 cm (6") SST pipe encasement.
½"-Supply & Return	241-Z to 81 cm (2'-8") from west wall of 241-ZA	SST	Pipeline has a 5 cm (2") SST pipe encasement.
3"-DR-M24	2736-ZB to pipe tie-in approximately 6 m (20') from west side of 241-Z	CS	
1"-CUU-5030-M9	236-Z west wall to 241-ZB	SST	Pipeline has a 10 cm (4") SST pipe encasement.
3"-D6	232-Z south wall to concrete encasement north of 241-Z	SST	
2"-LSW/HSW-M9	234-5Z south wall to 241-Z west wall	SST	Pipeline has a 15 cm (6") SST pipe encasement.
2"-LSW/HSW-M9	236-Z west wall to tie-in approximately 18 m (59') west of 236-Z	SST	In concrete trench.
3"-D8-1085	234-5Z south wall (Tunnel 3) to 241-Z north wall	SST	In concrete trench.
3"-D7-1084	234-5Z south wall (Tunnel 3) to 241-Z north wall	SST	In concrete trench.
8"-D6	234-5Z south wall (Tunnel 3) to 241-Z north wall	SST	In concrete trench.
4"-D4-1081	234-5Z north wall (Tunnel 3) to 241-Z north wall	SST	In concrete trench.
4"-D5-1082	234-5Z south wall (Tunnel 3) to 241-Z north wall	SST	In concrete trench.
4"&6"-Process Waste Drain	241-Z south wall (D4, D5, and D6 cells) to 241-Z-361 Settling Tank north wall	SST	Pipe size changes from 10 cm to 15 cm (4" to 6"). 241-Z-361 Settling Tank is addressed in DOE/RL-2003-52.
6"-Waste Water	241-Z-RB Retention Basin (west wall) to 241-Z-361 Settling Tank (north wall)	CS	241-Z-361 Settling Tank is addressed in DOE/RL-2003-52.
6"-Waste Water	241-Z-RB Retention Basin (south wall) to manhole #Z7 (near 2904-ZA)	CS	
8"-D3	South wall of 234-5Z to 241-Z-RB Retention Basin (west wall)	CS	
6"-Process Waste	Diversion Box No. 2 to 216-Z-12 Crib fence	SST	
8"-Process Waste	241-Z-361 Settling Tank to Diversion Box No. 1 (north wall)	SST	241-Z-361 Settling Tank is addressed in DOE/RL-2003-

Table 1-1. Structures and Installations in Engineering Evaluation and Environmental Analysis Scope[1]. (6 pages)

Pipeline Designation	Route	Material	Comments
			52.
6"&12"-Process Waste Drain	Diversion Box No. 2 to 216-Z-12 Crib fence	SST & VCP	Pipe material changes to VCP from SST at 30.5 cm x 15 cm (12" x 6") reducer.
6"-Process Waste	Diversion Box No. 1 to Diversion Box No. 2	SST	
4"&12"-Drain	Diversion Box No. 1 (southeast corner) to adjacent drain field	VCP	Pipe size changes from 10 cm to 30.5 cm (4" to 12").
8"-Process Waste Drain	Diversion Box No. 1 (south wall) to 216-Z-2 Crib fence	SST	
4"&12"-Drain	Diversion Box No. 2 (northwest corner) to adjacent drain field	VCP	Pipe size changes from 10 cm to 30.5 cm (4" to 12").
8"-VCP	Tie-in location into 20 cm (8") pipe between 216-Z-2 Crib and Diversion Box No. 1, to 216-Z-3 Crib fence	VCP	
1-½"&2"-M-21-1036	Near 242-Z Airlock to 216-Z-1A Tile Field fence	SST	
1-½"&2"-M-21-1035	West of 242-Z Airlock to 216-Z-1A Tile Field fence	SST	Near 242-Z, a portion of pipeline is located inside a concrete trench. Pipe sizes change from 3.8 cm to 5 cm (1-1/2" to 2").
1-½"-Hood 42	Tie-in at 1-1/2" P-M21-1036 Process drain pipe near 242-Z Airlock to 234-5Z	SST	In concrete trench.
1-½"-M-21-1036	242-Z Airlock to exit point from buried concrete trench	SST	In concrete trench.
4"-P-M21-1081	242-Z west wall to 234-5Z south wall	SST	In concrete trench.
4"-P-M21-1082	242-Z west wall to 234-5Z south wall	SST	In concrete trench.
3"-P-M21-1084	242-Z west wall to 234-5Z south wall	SST	In concrete trench.
3"-P-M21-1085	242-Z west wall to 234-5Z south wall	SST	In concrete trench.
4"-M21-D6	242-Z west wall to 234-5Z south wall	SST	In concrete trench.
2"-HSW-202-M8	241-Z south wall to Tank Farms (up to PFP outer fence)	SST	Pipeline has a 10 cm (4") SST pipe encasement.
2"-HSW-203-M8	241-Z south wall to Tank Farms (up to PFP outer fence)	SST	Pipeline has a 10 cm (4") SST pipe encasement.
1-½"-Drain	234-5Z east wall to 216-Z-9 Crib	SST	
1-½"-Drain	234-5Z east wall to 216-Z-9 Crib	SST	
1-½"-Drain	234-5Z east wall to 241-Z-8 Settling Tank	SST	
1-½"-Drain	234-5Z east wall to 241-Z-8 Settling Tank	SST	
3"-D6-Drain[2]	232-Z south wall to 241-Z north wall	SST	Drawing shows pipeline in 15 cm (6") pipe encasement. This line may not actually exist.
1-½"-P-M21-1020-HNO3	242-Z west wall to 241-Z north wall	SST	Partially routed through concrete trench.
1-½"-P-M21-1011-ANN	242-Z west wall to 241-Z north wall	SST	Partially routed through concrete trench.

Table 1-1. Structures and Installations in Engineering Evaluation and Environmental Analysis Scope[1]. (6 pages)

Pipeline Designation	Route	Material	Comments
1-½"-P-M10-1014-NAOH	242-Z west wall to 241-Z north wall	CS	Partially routed through concrete trench.
15" VCP	Manhole #Z1 (near 232-Z) to 216-Z-20 Crib (through manholes #Z2, #Z7, #Z8 and #2).	VCP	
15"-VCP	Manhole #Z6 (north of 241-ZB) to manhole #Z7 (near 2904-ZA)	VCP	
15"-VCP	Manhole #Z5 (south of 243-ZA) to manhole #Z6 (southwest of 243-ZA)	VCP	
15"-VCP	Manhole #Z4 (west of 236-Z) to manhole #Z5 (south of 243-ZA)	VCP	
3"-H22	236-Z to manhole #Z4 (west of 236-Z)	unknown	
6"-VCP	236-Z to manhole #Z4 (west of 236-Z)	VCP	
4"-CI	236-Z to manhole #Z4 (west of 236-Z)	CI	
6"-ABS	243-ZA sump to manhole #Z5 (south of 243-ZA)	ABS	In encasement pipe.
10"-CS	243-Z to 243-ZA sump	CS	
4"-CS	243-ZB to 243-ZA sump	VCP	
3"-CS	243-ZA sump to manhole #Z6 (southwest of 243-ZA)	VCP	
15"-VCP	Manhole #Z3 (west of 291-Z) to manhole #Z6 (southwest of 243-ZA)	VCP	
6"-VCP	291-Z to manhole #Z3 (west of 291-Z)	VCP	
3"-Acid Proof Chemical Drain	234-5Z to manhole #Z3 (west of 291-Z)	unknown	
4"-VCP	232-Z to tie-in east of 232-Z	VCP	
15"-VCP	Cleanout point (north of 232-Z) to manhole #Z1 (south of 232-Z)	VCP	
15"-VCP	Cleanout point (south of 2731-ZA) to manhole #Z1 (south of 232-Z)	VCP	
15"-VCP	Cleanout point (north of 2736-ZB) to cleanout point (south of 2731-ZA)	VCP	
6"-VCP	2736-ZB to tee west of 2736-Z	VCP	
6"-CS	Manhole (un-numbered, east of 2734-ZJ) to tee east of 2721-Z)	CS	
6"-CS	234-5Z to manhole (un-numbered, east of 2734-ZJ)	CS	
4"-CI	2736-ZB to tee (north of 2736-ZB))	CI	
15"-VCP	Cleanout point (south of 234-5Z) to Cleanout point (north of 2736-ZB)	VCP	
10"-VCP	234-5Z to tee south of cleanout point (south of 234-5Z)	VCP	
12"-VCP	234-5Z to tee south of cleanout point (south of 234-5Z)	VCP	
12"-VCP	234-5Z to tee (south of 234-5Z)	VCP	

Table 1-1. Structures and Installations in Engineering Evaluation and Environmental Analysis Scope[1]. (6 pages)

Pipeline Designation	Route	Material	Comments
12"-VCP	234-5Z to tee (south of 234-5Z)	VCP	
12"-VCP	234-5Z to tee (south of 234-5Z)	VCP	

[1] Reference H-2-832896, Rev. 0.
[2] Pipeline may not exist.

ABS = acrylonitrile butadiene styrene
CI = cast iron
CS = carbon steel
DR = drain
HSW = high salt waste
LSW = low salt waste
N/A = not applicable
P = process
PFP = Plutonium Finishing Plant
SST = stainless steel
VCP = vitrified clay pipe
UPR = unplanned release

Final cleanup of the PFP sub-grade structures and installations within the scope of this analysis will be coordinated with CERCLA remedial actions planned for the Central Plateau. This future work will be planned in remedial investigation/feasibility studies followed by proposed plans which will be issued for public comment.

1.3 241-Z TANK SYSTEM DISPOSITION

The *Hanford Facility Dangerous Waste Closure Plan, 241-Z Treatment and Storage Tanks*, (DOE/RL-96-82, Rev. 1) provides the process for closing the *Resource Conservation and Recovery Act of 1976* (RCRA) Storage Facility Permit for the 241-Z Tank system at PFP, and describes the process for the integration of the closure activities with CERCLA as appropriate. Under this closure plan, the 241-Z Facility is undergoing clean closure to the performance standards of *Washington Administrative Code* (WAC), with respect to dangerous waste contamination from RCRA operations. The unit will be clean-closed based on the physical closure activities under the closure plan and achieving clean-closure standards as described within the plan.

The 241-Z treatment, storage, and disposal (TSD) unit consists of below-grade tanks D-4, D-5, D-7, and D-8, an overflow tank located in a concrete containment vault, and associated ancillary piping and equipment. Waste managed at the TSD unit was received through underground piping from various PFP sources. The portions of the tank system and any remnants not removed after undergoing RCRA closure can remain in the 241-Z vault area and may be stabilized within the vault as necessary, pending CERCLA actions. Tank D-6 is a past-practice tank that will undergo decontamination activities under CERCLA. Tank D-6, its containment vault cell, and soils beneath the vault that were contaminated during past-practice activities (HNF-30654, *An Estimate of the Leakage from the 241-Z Liquid Waste Treatment Facility*) are evaluated as part of this analysis. Ancillary piping related to the TSD unit is also within the scope of this analysis.

Integration of RCRA and CERCLA activities is consistent with HFFACO Section 6.0 and the WA7890008967, *Hanford Facility Resource Conservation and Recovery Act Permit*, Section II.K.7, which encourage coordination of RCRA unit closure with other statutorily mandated cleanups to avoid duplication of effort, and with HFFACO Interim Milestone M-083-32 which reflects coordination of CERCLA actions(s) with 241-Z closure activities as needed.

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2.0 SITE CHARACTERIZATION

This chapter provides relevant background information and describes the physical features of the PFP Facility. It also describes the sub-grade structures and installations, including the buried pipelines, and the hazardous substances and risks associated with destination waste disposal sites. Information is provided for waste disposal sites and facilities that are not within the scope of this analysis in order to assess the potential risk associated with leaks from the pipelines that carried waste to those locations.

2.1 BACKGROUND AND SITE CONDITIONS

The PFP Facility is located on the Hanford Site in the 200 West Area (Figures 2-1 and 2-2) approximately 51 km (32 mi) northwest of the city of Richland, Washington. This section briefly describes the history and setting of PFP operations.

Figure 2-1. Hanford Site and Washington State.

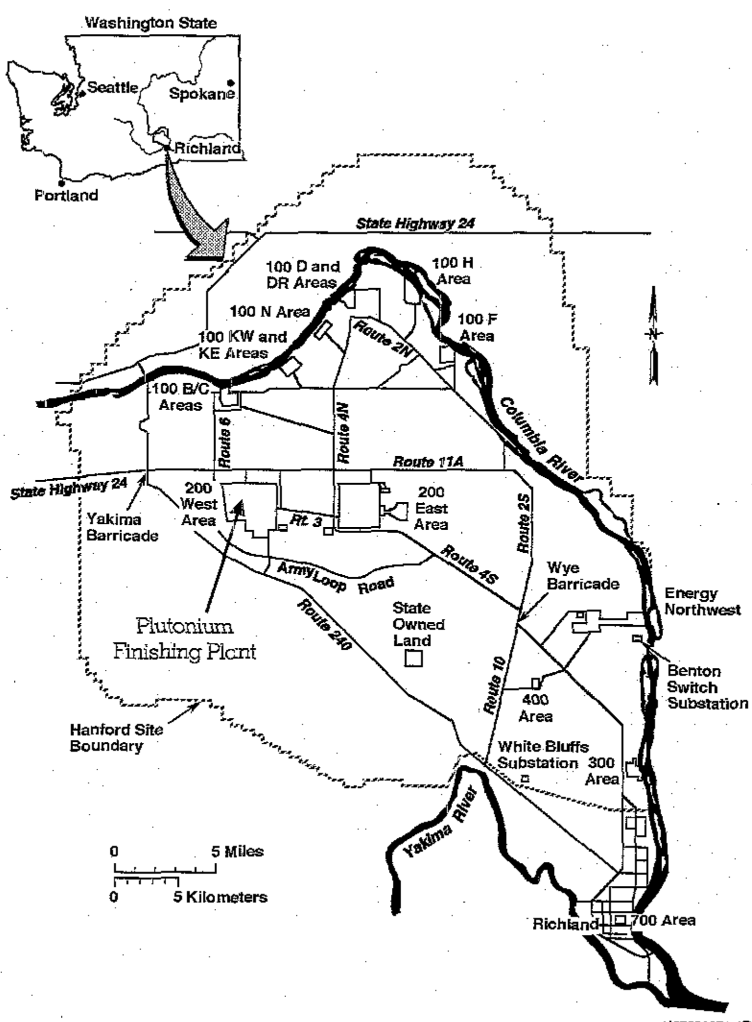
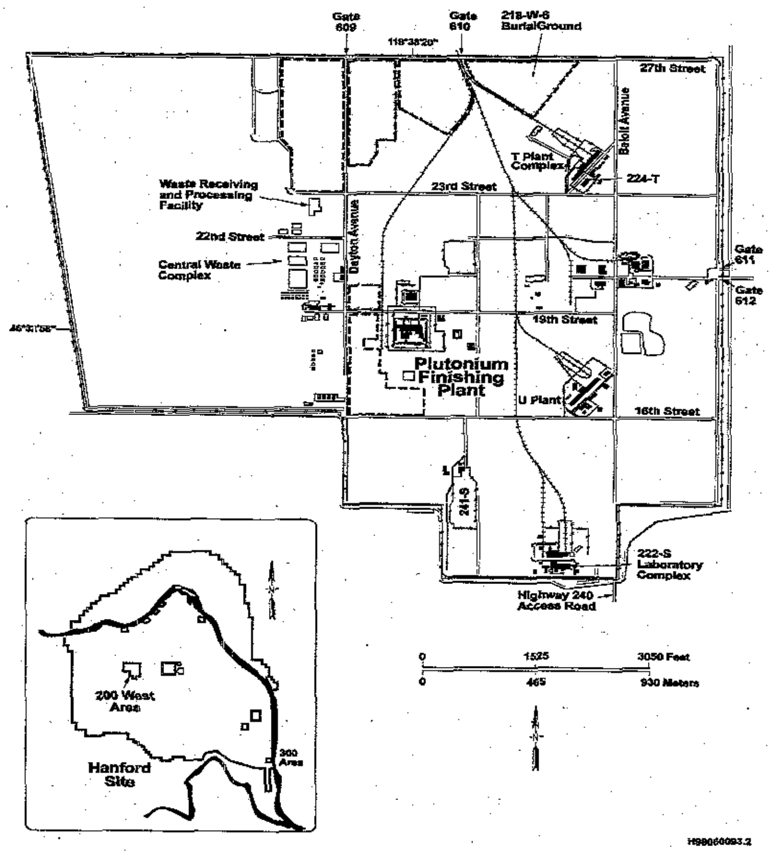


Figure 2-2. 200 West Area.



2.1.1 Background

The PFP Facility was used to conduct plutonium processing, storage, and support operations for national defense, including the following activities:

- Plutonium conversion and processing
- Fabrication of weapons components
- Production and blending of plutonium and uranium feed materials for advanced reactor fuel
- Plutonium and americium recovery
- Special nuclear material handling and storage
- Laboratory support
- Process waste handling.

Plutonium production operations ceased at PFP in 1990 under direction from DOE-Headquarters. Plant resources were then re-directed toward cleanout of the facilities and the stabilization/repackaging of the several tons of special nuclear material then in inventory. In October 1996, the DOE issued a letter, *Approval to Initiate Deactivation and Transition to the Plutonium Finishing Plan* (Ahlgrimm 1996), which directed the RL to "initiate deactivation and the transition of the PFP in preparation for decommissioning." Planning was initiated for integrating deactivation activities with the ongoing plutonium-bearing material stabilization activities in order to transition the PFP Facility to a low-risk/low-cost surveillance and maintenance (S&M) condition. Through fiscal year 1999, the life-cycle baseline for the PFP complex called for deactivation of the process facilities by 2014, offsite shipment of the special nuclear material inventory by 2027, deactivation of the storage vault facilities by 2028, and demolition of the complex and final remediation by 2038.

In 1997, an initial draft of an accelerated decommissioning plan was developed. The 1997 preliminary plan called for PFP to be deactivated by 2014, and the process and vault facilities to be transitioned to a dismantled state by 2016. The dismantlement end point would be removal of above-grade structures to the first floor concrete slab (clean slab-on-grade). The remaining concrete slabs and below-ground items (e.g., ducts, pipelines, French drains, etc.), utilities, and systems were planned for transferal to the D&D program pending final disposition. The DOE was unable to support the plan at that time, and it was not until the plan was expanded in May of 1999 (HNF-3617, *Integrated Project Management Plan for the Plutonium Finishing Plant Stabilization and Deactivation Project*) into a comprehensive project plan that integrated stabilization, special nuclear material de-inventory and D&D planning that DOE could utilize the acceleration concepts as the basis for a new PFP decommissioning plan. The May 1999 acceleration plan was ultimately implemented as the new PFP project baseline in fiscal year 2000, providing for demolition of the complex to slab-on-grade and transition of the remaining site to a safe, low-cost S&M condition by September 2016.

Despite a number of perturbations of the basic decommissioning plan since that time, the current plan for PFP Facility transition planning retains the September 2016 completion date for transition, as provided for in the *Plutonium Finishing Plant (PFP) Closure Project Execution Plan* (NMS-30425, Rev. 0).

2.1.2 Site Access

Public access to the Hanford Site, including the 200 Areas, is controlled at the Wye Barricade on Route 4, and the Yakima and Rattlesnake Barricades on State Highway 240. The Hanford Patrol is responsible for control at the barricades.

2.1.3 Current Land Use

All current land use activities associated with the 200 Areas and the Central Plateau are industrial in nature. The facilities located in the Central Plateau were built to process irradiated fuel from the plutonium production reactors in the 100 Areas. Most of the facilities directly associated with fuel reprocessing are now inactive and awaiting final disposition. Several waste management facilities operate in the 200 Areas, including permanent waste disposal facilities such as the Environmental Restoration Disposal Facility (ERDF) and the RCRA-permitted, mixed-waste trenches. Construction of tank waste treatment facilities in the 200 Areas began in 2002, and the 200 Areas are the planned disposal location for the vitrified low-activity tank wastes. Past-practice disposal sites in the 200 Areas are being evaluated for remediation and are likely to include institutional controls (e.g., deed restrictions or covenants) as part of the selected remedy. Other federal agencies, such as the U.S. Department of the Navy, also dispose of materials at the Hanford Site 200 Areas nuclear waste TSD facilities. A commercial low-level radioactive waste disposal facility, operated by US Ecology, Inc., currently operates on a portion of a tract in the 200 Areas leased to the state of Washington.

2.1.4 Reasonably Anticipated Future Land Use

The DOE-identified reasonably anticipated future land use for the area surrounding the PFP Complex and waste sites, documented through the land use ROD (64 FR 61615, *Hanford Comprehensive Land-Use Plan Environmental Impact Statement, Hanford Site, Richland, Washington: Record of Decision*), is industrial (exclusive) for sites located within the exclusive-use boundary (core zone).

According to DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (CLUP–EIS), industrial (exclusive) land use would preserve DOE control of the continuing remediation activities and would use the existing compatible infrastructure required to support activities such as dangerous waste, radioactive waste, and mixed-waste TSD facilities. The DOE and its contractors, and the U.S. Department of Defense and its contractors, could continue their federal waste disposal missions; and the Northwest Low-Level Radioactive Waste Compact could continue using the US Ecology site for commercial radioactive waste. Research supporting the dangerous waste, radioactive waste, and mixed-waste TSD facilities also would be encouraged within this land-use designation.

The CLUP-EIS was written to address the growing need for a comprehensive, long-term approach to planning and development on the Hanford Site because of the DOE's separate missions of environmental restoration, waste management, and science and technology. The CLUP-EIS analyzes the potential environmental impacts of alternative land use plans for the Hanford Site and considers the land use implication of ongoing and proposed activities.

Under the preferred land use alternative selected in the ROD (64 FR 61615), the reasonably anticipated future land use for the area inside the core zone of the Central Plateau is industrial (exclusive) use. The current vision for the 200 Areas is that it will continue to be used for the TSD of hazardous, dangerous, radioactive, and nonradioactive wastes. The CLUP-EIS and ROD incorporate this vision in the selected alternative, describe the means by which new projects will be sited, and focus on using existing infrastructure and developed areas of the Hanford Site for new projects.

To support the current vision, the 200 Areas projects will maintain current facilities for continuing missions, remediate soil waste sites and groundwater to support industrial land uses, lease facilities for waste disposal (i.e., US Ecology), and demolish facilities that have no further beneficial use. Based on the CLUP-EIS and associated ROD, and consistent with other Hanford Site waste management decisions, this analysis assumes an industrial (exclusive) land use for the sub-grade structures and installations because they are within the core zone.

2.1.5 Flora and Fauna

Details regarding the Hanford Site can be found in the *Hanford Site 2004 Environmental Report* (PNNL-15222) *and Hanford Site National Environmental Policy Act (NEPA) Characterization* (PNL-6415).

The PFP Facility is not located within a wetland or a floodplain. PFP is in an industrialized area with ongoing construction, processing, decommissioning and demolition activities. What little plant community does exist consists primarily of semi-arid species common to disturbed areas, such as cheatgrass, rabbitbrush, and other non-native plant species. Threatened and endangered plants and animals identified on the Hanford Site, as listed by the federal government (Title 50 Code of Federal Regulations [CFR] 17) and Washington State (Washington National Heritage Program 2002), generally are not found in the vicinity of PFP and are discussed in PNL-6415. However, migratory birds (including the house finch, Say's phoebe, barn swallow, violet-green swallow, American robin, and western kingbird) and/or their nests have been observed within the PFP area (50 FR 13708). No plants or animal species protected under the *Endangered Species Act of 1973*, candidates for such protection, or species listed by the Washington State government as threatened and endangered have been observed in the vicinity of the PFP Facility. There are, however, two species of birds (Aleutian Canada goose and bald eagle) on the federal list of threatened and endangered species that have been observed on the Hanford Site. Additional details regarding the protection and enhancement of the bald eagle Hanford Site habitat are provided in the *Bald Eagle Site Management Plan for the Hanford Site, South-Central Washington* (DOE/RL-94-150).

Deactivation activities will be consistent with the *Hanford Site Biological Resources Management Plan* (DOE/RL-96-32) and *Hanford Site Biological Resources Mitigation Strategy* (DOE/RL-96-88). An ecological resource review is conducted annually at the PFP Facility. As appropriate, certain restrictions might be applied as a result of these reviews. For example, during nesting periods (i.e., late April through late July), active nests for species protected under federal and state laws should not be moved/destroyed or the structure supporting the nest should not be deactivated/dismantled until the young have fledged (left the nest) without consultation with Pacific Northwest National Laboratory.

2.1.6 Cultural Resources

General information regarding cultural resources on the Hanford Site can be found in PNL-6415. A number of site-specific cultural resource reviews for deactivating and dismantling the PFP Facility have been conducted. Findings and/or restrictions have been identified in these reviews and are summarized below. In addition, activities to locate, identify and tag artifacts within PFP, and to document the history and role of PFP, have been performed.

In January 2003, the State Historic Preservation Office (SHPO) (Griffith 2003, *Deactivation and Decommissioning of Historic Buildings at the PFP Complex, HCRC 2002-200-021*) agreed that because of public health and safety concerns posed by high radiological contamination levels, public access to the PFP would be unlikely; therefore, transition (deactivation and demolition) activities could proceed. In September 2003, the SHPO concurred that no historic properties would be affected by extending deactivation activities approximately 305 m (1,000 ft) laterally outside the PFP Complex fence line, with associated excavation to approximately 6 m (20 ft).

2.2 GEOLOGY

The PFP is located in the 200 West Area which is in the Pasco Basin, a topographic and structural depression in the southwest corner of the Columbia Basin physiographic subprovince. Generally, this subprovince is characterized as relatively flat, low-relief hills with moderately incised river drainages.

The Columbia Basin subprovince is underlain by the Columbia River Basalt Group, which consists of a thick sequence of Miocene basalt flows that are approximately 17 to 6 million years in age. The thickest accumulations occur in the Pasco Basin where the basalt thickness is greater than 3 km (1.8 mi).

Two primary sedimentary rock units overlie the Columbia River Basalt in the 200 West Area: 1) Pliocene fluvial and luscustrine deposits of the Ringold Formation, and 2) Pleistocene flood deposits of the Hanford formation. In addition, two discontinuous units of calcium carbonate cemented silts, sands, and gravels (caliche) occur locally between the Ringold Formation and the Hanford formation in the 200 West Area. The total thickness of the sedimentary section above basalt in the vicinity of PFP is approximately 162 m (530 ft). These units become thicker several miles to the south of PFP toward the axis of the Cold Creek Syncline and thinner toward the north against the flanks of Gable Mountain and Gable Butte.

Additional details describing the geology in the 200 West Area are provided in the *Z-Plant Source Aggregate Area Management Study Report* (DOE/RL-91-58), *Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit RI/FS Work Plan: Includes the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units* (DOE/RL-2001-01), and PNL-6415.

2.3 PFP AREA WATER RESOURCES AND HYDROLOGY

The Water Resources and Hydrology section presents existing information on the baseline conditions for surface water, the vadose zone, and groundwater at the site. Each of these hydrological regimes may be affected by the alternatives and each regime would be affected differently. Section 2.3.1 describes the surface water at the site. Section 2.3.2 characterizes the site vadose zone. Section 2.3.3 describes the groundwater at the site. Additional details describing the water resources and hydrology in the 200 West Area are provided in DOE/RL-2001-01 and PNL-6415.

2.3.1 Surface Water

There is one naturally occurring lake on the Hanford Site, Westlake, which is located approximately 8 km (5 mi) northeast of the 200 West Area. The lake is situated in a topographically low-lying area and is sustained by groundwater inflow resulting from intersection with the groundwater table. Seasonal water table fluctuations are not large.

Two ephemeral creeks, Cold Creek and its tributary Dry Creek, traverse the uplands of the Hanford Site southwest and south of the 200 West Area. The confluence of the two creeks is 5 km (3 mi) southwest of the 200 West Area. Surface runoff from the uplands in and west of the Hanford Site is small. In most years, measurable flow occurs only during brief periods and in only two places, upper Cold Creek Valley and upper Dry Creek Valley.

The Columbia River is down-gradient from the PFP Facility, lying nearly 11 km (7 mi) north of the 200 West Area. The river forms part of the eastern boundary of the Hanford Site and comprises the base level and receiving water for groundwater and surface water in the region.

Natural flooding on the Columbia River would be restricted to the immediate floodplain of the river. Failure of the upstream dams due either to natural causes or sabotage would not likely affect the PFP Facility.

There are no floodplains in the 200 West Area. Floods in Cold and Dry Creeks have occurred historically. However, there have not been any flood events or evidence of floods in these creeks reaching the highlands of the 200 West Area before infiltrating into pervious sediments of Cold Creek Valley.

Water quality in the ephemeral creeks is not known to be affected by Hanford Site activities. The state of Washington has classified the stretch of the Columbia River from Grand Coulee to the Washington-Oregon border, which includes the Hanford Reach, as Class A, Excellent. Class A waters are suitable for essentially all uses, including raw drinking water, recreation, and wildlife habitat. State and federal drinking water standards apply to the Columbia River and are currently being met.

2.3.2 Vadose Zone

The vadose zone extends from the ground surface to the top of the groundwater. Vadose zone characteristics determine the rate, extent, and direction of liquid flow downward from the surface.

Recharge to the unconfined aquifer is primarily from artificial sources. The principal source of artificial recharge was from waste management units located in the 200 West and 200 East Areas. However, liquid discharges to these waste units have ceased.

Natural recharge occurs chiefly from precipitation as there is no natural surface water bodies in the 200 West Area. Average annual precipitation in the 200 West Area is approximately 16 cm (6.3 in). Estimates of evapotranspiration from precipitation range from 38 to 99%.

The total natural recharge in the 200 West Area is estimated to be approximately 129 million L (34 million gal) per year. These natural recharge values are significantly lower by an order of magnitude than volumes disposed of (historically) by artificial sources.

In areas where artificial recharge is occurring from ponds and trenches, soils are likely to be close to saturation and could not hold significant amounts of additional liquid. In addition, groundwater mounds have developed beneath these recharge areas. Drier soils in other areas of the 200 West Area where artificial recharge is not occurring has a large moisture holding capacity. Perched water was reported between 30 and 35 m (97 and 115 ft) below ground surface.

2.3.3 Groundwater

Groundwater generally occurs under confined conditions within sedimentary interbeds associated with the basalt sequence and under unconfined conditions within the overlying sedimentary section (uppermost aquifer).

Across the 200 West Area, the regional groundwater flow is toward the north, east, and southeast. Regional groundwater discharge occurs along the course of the Columbia River, which is nearly 11 km (7 mi) north of the 200 West Area.

Generally, groundwater within the Ringold Formation in the 200 West Area occurs under unconfined conditions and is located approximately 70 m (230 ft) beneath the PFP Facility.

Groundwater has been contaminated by both radionuclide and nonradionuclide contaminants in the 200 West Area. Remedial strategies for the Hanford Site have been developed or are being developed to contain and remediate the contaminants and prevent their migration offsite. In general, downward vertical gradients exist between the unconfined and deeper confined aquifers across the 200 West Area.

Fourteen overlapping contaminant plumes are located within the unconfined gravels in the 200 West Area: Technetium-99, uranium, nitrate, carbon tetrachloride, chloroform, trichloroethylene, iodine-129, gross alpha, gross beta, arsenic, chromium, fluoride, tritium, and plutonium. Five of these plumes (carbon tetrachloride, chloroform, nitrate, trichloroethylene, and plutonium) impinge upon or encompass the ground below the PFP Facility.

Groundwater is not used in the 200 West Area. Water for drinking and emergency use and PFP process water comes from the Columbia River. Regionally, groundwater is used for irrigation and domestic water supply. On the Hanford Site, the nearest water supply wells are located at the Yakima Barricade approximately 5 km (3.1 mi) west of the 200 West Area.

Hydraulic conductivities measured in the 200 West Area range from approximately 0.02 to 61 m/day (0.06 to 200 ft/day). Transmissivities of Ringold Unit E in the vicinity of the PFP Facility range from 0.015 m^2/sec (14,000 ft^2/day) in Well 299-W15-18 situated approximately 76 m (250 ft) west of the PFP Facility to 0.005 m^2/sec (5,000 ft^2/day) in Well 299-W15-16 located approximately 79 m (260 ft) northwest of the PFP Facility. Hydraulic conductivities in the same wells ranged from 0.49 to 0.42 cm/sec (1,400 to 1,200 ft/day), respectively.

2.4 PFP FACILITY SITE DESCRIPTION

This section describes the facilities and chemical processes associated with PFP sub-grade structures and installations within the scope of this analysis, and summarizes the known chemical and radiological contamination associated with these structures and installations. The historical descriptions in this section are provided to present information on the waste sources that contributed to contamination of the structures and installations that are the subject of this analysis. A detailed overview of the chemical processes and liquid effluent waste streams generated at PFP can be found in the *Study of Liquid Effluents and CERCLA Hazardous Constituents Generated and Discharged by the Plutonium Finishing Plant* (D&D-30349).

2.4.1 Buildings and Processes

The following section provides an overview of the process buildings and production processes that took place within the PFP, as well as the waste treatment and disposal activities that may have contributed to contamination of the sub-grade structures and installations. The buildings within PFP will be demolished to slab-on-grade based on analysis performed through the PFP above-grade structures EE/CA (DOE/RL-2004-05) and the 232-Z EE/CA (DOE/RL-2003-29); however, the buildings are described in their prior-to-dismantled condition to provide a context for understanding waste characteristics and waste transfer methods that might have contributed to sub-grade contamination.

2.4.1.1 234-5Z Building

The 234-5Z Building historically was the site of the primary plutonium finishing facility. Plutonium nitrate was converted to product forms, primarily metal and some oxide. Three processing lines operated inside the 234-5Z Building: the Rubber Glove (RG) Line (1949-1953), the Remote Mechanical "A" (RMA) Line (1953-1979), and the Remote Mechanical "C" (RMC) Line (1969-1973 and 1985-1988). Figures 2-3, 2-4, and 2-5 show the construction stages of the 234-5Z Building.

Figure 2-3. 234-5Z Building Construction Photo 1.

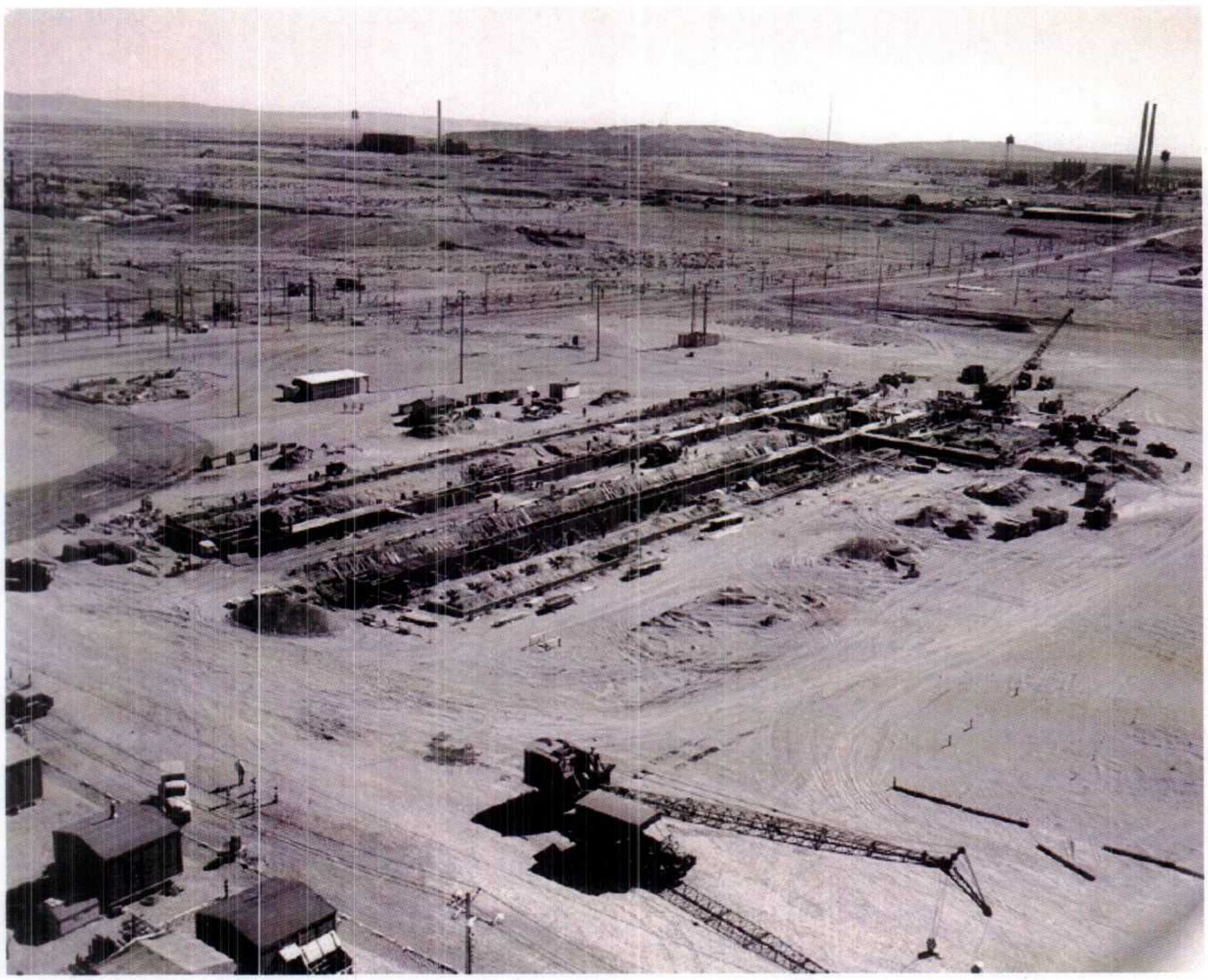


Figure 2-4. 234-5Z Building Construction Photo 2.

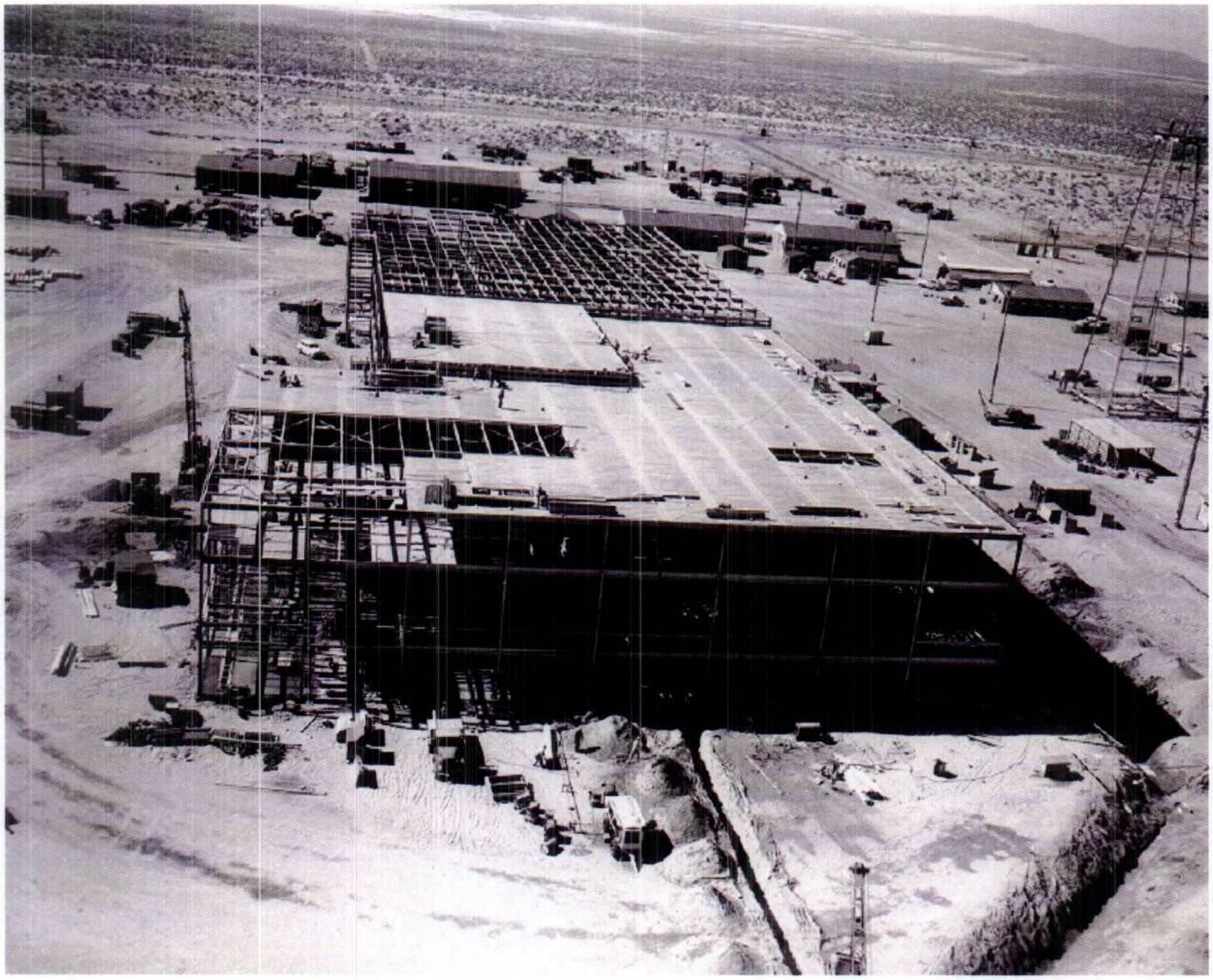


Figure 2-5. 234-5Z Building Construction Photo 3.

The production processes generated large quantities of scrap, which required the development of complex scrap recovery operations involving cleaning, recovery, and chemical dissolution, followed by solvent extraction refining. These recovery processes included activities at the Recovery of Uranium and Plutonium by Extraction (RECUPLEX) Facility, until 1962, followed by the Plutonium Reclamation Facility (PRF), which operated from 1964 until 1989. Although other activities at PFP also generated liquid waste effluent, the waste from the RG, RMA, RMC, and RECUPLEX/PRF processes comprised the majority of the liquid effluent discharged to the buried pipeline systems. Historically, liquid wastes from these operations contained traces of plutonium, other transuranic elements, and process chemicals, which were routed to the waste disposal sites described below in Section 2.4.3.

The analytical and development laboratories at PFP were housed in the 234-5Z Building. The laboratories have provided support to process operations in the following areas: process control, quality assurance/quality control for process lines, liquid scintillation counting, and preparation work for solvent extraction tests.

Spills from and within gloveboxes, process lines, and movement of process materials within the building created multiple contamination zones associated with the 234-5Z Building. The majority of this contamination will be removed and disposed during the implementation of the pathway established through the PFP above-grade structures EE/CA. Based on information provided in the *Plutonium Finishing Plant Operations Overview (1949-2004)* (HNF-22064), it is estimated that less than 10 gram (0.35 oz) of plutonium will remain on the slab of the 234-5Z Building. Once the building slab is stabilized, it is anticipated that the slab will be covered with a contamination control cap. The following paragraphs discuss specific processes within the 234-5Z Facility and related sub-grade waste disposal pathways.

234-5Z Liquid Process Waste Streams. The liquid process waste streams from the 234-5Z Building (i.e., RG, RMA, RMC) can be characterized as generally acidic and highly corrosive (pH~2), often high in salts, and low in organic content. The wastes contain minor amounts of fission products, and low concentrations of plutonium and other transuranic elements. The wastes were high in nitrates in the form of nitric acid, magnesium nitrate, ferric nitrate, and calcium nitrate. Other compounds in the wastes included aluminum fluoride, potassium hydroxide, potassium fluoride, chromium, lead, and other trace metals. Process lines exit the building vertically through the building slab in several locations, turning horizontally through buried pipe trenches or at times direct-buried to re-enter the below-grade concrete pipe tunnels before exiting the south side of the building. Some of these single-wall pipelines potentially leaked prior to entering the pipe tunnel. The wastes from these processes also potentially contributed to contamination of the building slab through spills and leaks in process areas.

Wastes that were discharged from the 234-5Z Facility to the 241-Z Facility underwent treatment through addition of sodium hydroxide, ferric nitrate, and sodium nitrite for stabilization and neutralization. Corrosion inhibitors, such as sodium nitrite and aluminum compounds, also were sometimes added. Process wastes from the 234-5Z Facility were disposed to various facilities, including the 216-Z-1, 216-Z-2, and 216-Z-3 Cribs, each of which overflowed to the 216-Z-1A Tile Field, and the 216-Z-12 Crib. After 1973, the process wastes were transferred to the tank farms.

RECUPLEX Process Waste Streams. DOE used the RECUPLEX process from 1955 to 1962 to recover plutonium from PFP scrap. The process used a solvent extraction technology and was housed in the 234-5Z Building. The process generated three primary waste streams:

- Spent aqueous extractant
- Spent organic solvents
- Waste silica gel.

The spent aqueous extractant from RECUPLEX is characterized as an acidic, high salt, radioactive liquid waste containing low levels of plutonium and other transuranic elements. Nitric acid, fluoride, and phosphate are major components of the waste. Carbon tetrachloride was used in combination with tributyl phosphate (TBP) to remove residual plutonium from the aqueous solution prior to discharge to the 216-Z-9 Crib.

The organic process waste from RECUPLEX is characterized as acidic (~pH 2.5), low-salt, high organic, radioactive waste with intermediate levels of plutonium and other transuranic elements.

Major chemical components of the waste are carbon tetrachloride, TBP, dibutylbutyl phosphonate (DBBP), which played a minor role in RECUPLEX processes, and degradation byproducts. As the carbon tetrachloride/TBP solvent degraded, it was replaced with fresh solvent and the degraded mixture was discharged to the 216-Z-9 Crib through two stainless steel pipelines. Operating procedures indicate that the waste to the 216-Z-9 Crib was neutralized prior to discharge and that the pipeline was flushed with clean rinse water after each waste discharge batch (HW-35030, *RECUPLEX Operating Manual, 324-5 Development Plant Processes Sub-Section*).

The waste silica gel from RECUPLEX was sent to the 241-Z-8 Settling Tank through a pair of stainless steel pipelines. Overflow from the settling tank was discharged to the 216-Z-8 French Drain. This waste was neutralized by the addition of sodium hydroxide prior to discharge from RECUPLEX and the pipeline was flushed to the settling tank after each release (RHO-RE-EV-46P, *216-Z-8 French Drain Characterization Study*).

The RECUPLEX waste streams are unique among those at PFP in that each of these waste streams was discharged to a dedicated facility, facilitating an understanding of the waste characteristics for those pipelines. In addition, records indicate that the waste pipelines from RECUPLEX were routinely flushed with clean rinse water, significantly reducing the likelihood of corrosion or residual waste constituents in these pipelines.

PFP Analytical and Development Laboratories. The PFP Laboratory areas produced three types of waste:

- Laboratory process wastes
- Used or discarded analytical reagents and chemicals
- Wastewater from laboratory sinks and emergency showers.

Laboratory process wastes were characterized as slightly acidic, low-salt radioactive waste. These wastes were routed along with process wastes through the 241-Z-361 Settling Tank to various cribs. The 216-Z-3 and 216-Z-12 Cribs received laboratory process wastes after the pH was adjusted to between 8 and 10 in the 241-Z treatment tanks.

Small quantities of a large number of chemicals were used or stored in the laboratories. Little information is available on the disposition of used or discarded analytical reagents. The laboratories operated under procedures that included inventory management of the raw chemicals, however, and it is unlikely that significant volumes were discharged through waste lines.

Nonradiological laboratory sinks and emergency showers in the laboratory areas drain to the main wastewater system in the 234-5Z Building. This wastewater likely contained intermittent releases from laboratory procedures, glassware cleaning, and chemical spills.

Non-Contact Wastewater. Non-contact wastewater (i.e., wastewater that does not come into direct contact with any of the plutonium separations processes) was generated through multiple activities and sources at PFP. It can be characterized as low in salt, low organic, neutral to basic aqueous waste. Although pipelines that carried such liquids should not have received contaminated effluent, records suggest that some inadvertently received chemical or radionuclide waste. Because these lines did not routinely transport high concentrations of hazardous or radioactive wastes, leaks from these pipelines or remaining residues should not contain sufficient concentrations of hazardous substances to present a threat to human health or the environment and will not be further discussed in this analysis. Nonetheless, discharge pipelines for this system composed mostly of vitrified clay pipe, which could potentially retain some radionuclides and would be more prone to cracks, leaks, and split joints, will be retained for evaluation through this analysis.

2.4.1.2 232-Z Building

The 232-Z Building housed a dry waste incinerator, which incinerated plutonium-contaminated solid wastes in preparation for plutonium recovery. The building also housed equipment for leaching of solid wastes not suitable for incineration, as well as offgas treatment. Historically, the 216-Z-1A Tile Field received aqueous wastes from the 232-Z Building.

Spills of incinerator ash, leaching solution, and scrubber solution contaminated the building slab. This structure was evaluated under its own EE/CA (DOE/RL-2003-29). The building was demolished to slab-on-grade in June 2006 and the transite, belowground exhaust duct to the 291-Z Building was filled with a concrete. The building slab has been stabilized with a contamination control cap (see Figure 2-6).

Figure 2-6. 232-Z Building Slab-on-Grade.

2.4.1.3 236-Z Building

The 236-Z Building houses the PRF process equipment, which recovered plutonium from scrap solutions within PFP and other DOE facilities. PRF wastes were similar to RECUPLEX wastes, with the addition of more significant volumes of DBBP as a process chemical. Plutonium recovery process wastes were routed to the 241-Z-361 Settling Tank via a stainless steel pipeline before being discharged to cribs and trenches (e.g., 216-Z-1A Tile Field, 216-Z-1 and 216-Z-2 Cribs, and 216-Z-18 Crib). Spills and leaks of process liquids and wastes contributed to contamination of the 236-Z Building slab. The slab below the Cell 12 floor pan is expected to be very highly contaminated due to leaks in the stainless steel pan. Based on information provided in HNF-22064, it is estimated that more than 50 grams (1.8 oz) of plutonium may remain on the slab of the 236-Z Building at this location after building demolition. It is anticipated that the 236-Z Building slab will be stabilized with a contamination control cover after building demolition.

A 132 cm to 213 cm (52 in. by 84 in.) sub-grade duct carries exhaust air from the 236-Z Building to the 291-Z Exhaust Facility and another smaller exhaust duct, 122 cm by 122 cm (48 in. by 48 in.), extends from Stairway 2 to Room 18 beneath the 236-Z Building.

Low-level wastewater from equipment cooling water; heating, ventilation, and air conditioning (HVAC) condensate; process cooling water; and steam condensate discharged to three piping headers which routed the effluent to the 216-Z-20 Crib.

2.4.1.4 241-Z Building

The 241-Z Building housed equipment that was used to temporarily store and treat process effluents from the PFP. The facility includes five, 15,900 L (4,198 gal) below-grade tanks housed in concrete vaults that will remain after implementation of recommendations in the PFP above-grade structures EE/CA. The tanks are discussed in more detail later in this chapter. There is a history of leaks from one of the tanks, which contaminated the interior of the concrete vaults and may have contributed to soil contamination beneath the vaults. The nature and extent of this contamination has not been quantified; however, it is estimated that approximately 200 grams (7 oz) of plutonium are present in the vaults. Upon completion of the activities to implement the recommendations in the PFP above-grade structures EE/CA, it is anticipated that the 241-Z Facility will receive a gravel cover and a contamination control cover. Figure 2-7 shows the 241-Z Facility during construction. The pipe trench from 234-5Z to 241-Z is also visible.

Figure 2-7. 241-Z Facility During Construction.

The 241-ZA Sample Building is located just east of the 241-Z Building and houses a sampling glovebox for process waste. Spills from the sample piping have contaminated the 241-ZA Sample Building concrete slab.

Pipelines from the south side of the 234-5Z Building carried process wastes to the 241-Z Facility. After treatment, many of these wastes were routed through the 241-Z-361 Settling Tank before discharge to cribs. Transfer line D-8 was flushed after its last use; the line that discharged waste to tank farms was double-flushed before the line was isolated (HNF-30205, *241-Z D-8 Cell RCRA Closure*).

2.4.1.5 241-Z-RB Retention Basin

The 241-Z-RB retention basin, also called the 207-Z Facility, was built in 1949 and is located to the south and east of the 241-Z Building. This structure is comprised of two, side-by-side concrete wastewater retention basins that are each approximately 12 m (40 ft) long, 7 m (24 ft) wide, and 4 m (12 ft) deep. Adjacent to the west wall of the basin is the 241-Z-RB valve pit. This valve pit measures approximately 5 m (16 ft) long by 4 m (12 ft) wide and is 4.4 m (14.5) ft deep.

The structure was used to hold wastewater from the 241-Z complex. Wastewater having low levels of radioactivity was discharged to the 216-Z-19 Trench or the 216-U-10 Pond. The basins and valve pit have been filled with controlled-density fill and covered with a contamination control cap. Figure 2-8 shows the retention basin before, during, and after being filled.

Figure 2-8. 241-Z-RB Demolished to Slab-on-Grade.

2.4.1.6 242-Z Building

The 242-Z Building housed the americium recovery process line and operated from 1964-1976. Liquid wastes from this facility consisted of nitric acid with traces of transuranic elements and metals; DBBP also was used in this process. The waste stream included waste organic solvent and un-recovered americium. The waste stream was routed to the 241-Z-361 Settling Tank via the 241-Z Building, and then discharged to the 216-Z-1A Tile Field and the 216-Z-18 Crib. Beginning in 1973, the wastes were routed to the tank farms.

A chemical explosion at the 242-Z Building in 1976 stopped operations and resulted in extensive contamination of the building interior, including the building slab. Based on information provided in HNF-22064, it is estimated that approximately 20 grams (0.7 oz) of plutonium will remain on the slab of the 242-Z Building after building demolition. It is anticipated that the building slab will be covered with a contamination control cover after building demolition.

2.4.1.7 243-Z Building Description

The 243-Z Building, known as the Low-Level Waste Treatment Facility, was constructed in 1994 and is located east of the 291-Z Building. The building is approximately 21 m (70 ft) long, 11 m (35 ft) wide and 4.5 m (15 ft) high, is constructed of corrugated steel, and sits on a concrete slab. The process area included two media trains consisting of tanks, pumps, filters, and the necessary piping and instrumentation for operation and monitoring the equipment and incoming waste streams, and treatment of the PFP effluents to remove low-level radioactive and chemical contamination. The 243-ZA structure, located east of the 243-Z Building, is a sump that is divided into an upper and lower sump. The lower sump is a concrete pit that is approximately 5 m (16 ft) by 5 m (16 ft) and approximately 5.5 m (18 ft) deep. The upper sump is a tank basin at grade level that is surrounded by a 1 m (3 ft) retaining wall. Each of these facilities is considered to be contaminated. It is anticipated that a contamination control cover will be installed at this location as part of the implementation of the PFP above-grade structures EE/CA.

2.4.1.8 291-Z Building

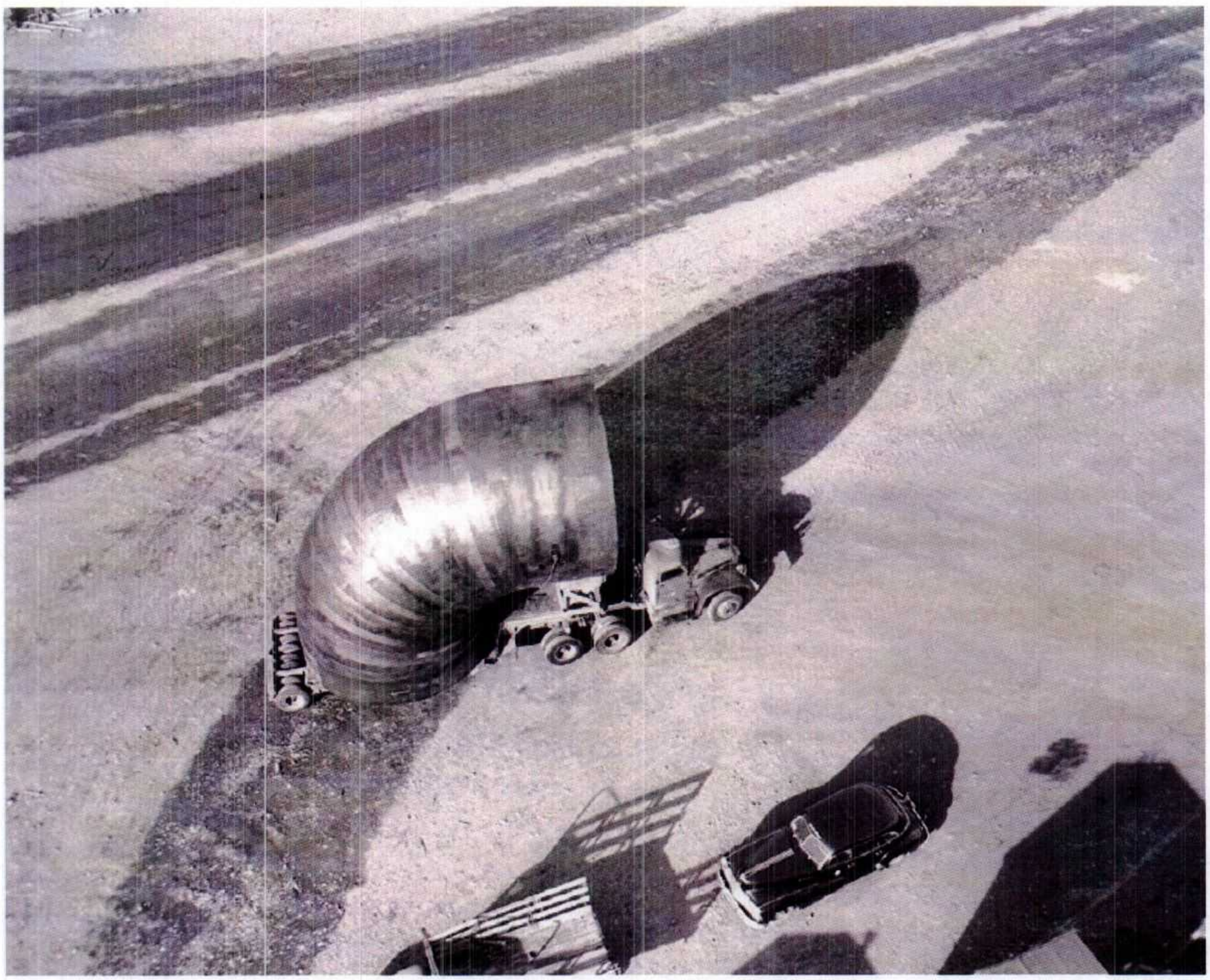
The 291-Z Building houses ventilation exhaust fans, instrument air compressors, and vacuum pumps to handle exhaust from the 234-5Z, 232-Z, 236-Z, and 242-Z Buildings. Routine effluents from the 291-Z Building include non-contact cooling and condensate wastewater from HVAC equipment, cooling water for compressors, and vacuum pump seal water. These wastes discharged to the following units:

- 216-Z-13 French Drain
- 216-Z-14 French Drain
- 216-Z-15 French Drain.

The plenum, ductwork, and sections of the interior, below-grade slab and concrete of the 291-Z Building are contaminated from constituents in the exhaust from process areas. Based on information provided in HNF-22064, it is estimated that less than 20 grams (0.7 oz) of plutonium will remain on the slab of Room 501, with an equivalent amount in Room 505.

Two belowground exhaust chambers from the 291-Z Exhaust Building are connected to the 291-Z-001 Stack by a tapered duct, which transfers exhaust air into the stack through a 5 m (16 ft) diameter concrete elbow. Figure 2-9 shows the turning elbow that is now enclosed in the stack base. The entirety of the exhaust system lying downstream of the final banks of high-efficiency particulate air filters is estimated to be contaminated with between 2 and 20 grams (0.07 and 0.7 oz) of plutonium from exhaust gases. This ductwork is not expected to be filled as part of the implementation of the PFP above-grade structures EE/CA.

Figure 2-9. 291-Z Stack Turning Elbow.



2.4.1.9 2736-Z Building

The 2736-Z Building is used for plutonium storage. Routine effluents from the building are limited to cooling and condensation wastewater from HVAC equipment and air compressors. The 2736-ZA Plutonium Storage Ventilation Structure and the 2736-ZB Plutonium Storage Support Facility are located immediately west and south, respectively, of the 2736–Z Building. The building slab at each of these locations is considered to have some level of contamination. It is anticipated that each of these building slabs will receive a contamination control cover after building demolition.

2.4.2 Tanks

In general, below-grade tanks (settling tanks) will be addressed under another regulatory program or under an interim action (e.g., the 241-Z-361 Settling Tank is evaluated through DOE/RL-2003-52). Nonetheless, they are described here because the sub-grade process pipelines that transferred waste to these tanks are within the scope of this analysis for residual hazardous constituents or leakage of hazardous substances to surrounding soils. The decontaminated 241-Z vault tanks are also within the scope of this analysis.

There is an underground diesel storage tank adjacent to the 2721-Z Building for the emergency generators. This tank is active and permitted and has no history of releases. It is expected that this tank will undergo the appropriate RCRA closure process when it is no longer required. This diesel storage tank and its associated pipelines are not within the scope of this analysis.

2.4.2.1 241-Z-8 Settling Tank

The 241-Z-8 Settling Tank is an underground inactive waste management unit located east of the 234-5Z Building. The approximately 57,500 L (15,444 gal) carbon steel tank was used as a settling tank for the backflush of feed filters for the RECUPLEX process, which was routed to the tank via two stainless steel pipelines. Liquid waste overflowed from the settling tank to the 216-Z-8 French Drain (discussed in Section 2.4.3). In April 1974, the tank was estimated to contain 29,081 L (7,677 gal) of liquid and 1,888 L (498 gal) of sludge. The plutonium content of the tank was estimated at approximately 1.6 kg (3.53 lbs). The tank was pumped in the fall of 1974 to remove the liquid portion of the contents; the majority of the sludge remains in the tank (RHO-RE-EV-46P). This tank is undergoing investigation as part of the 200-PW-6 OU.

This analysis is concerned with the stainless steel pipelines that carried waste from RECUPLEX to the settling tank. Process records for RECUPLEX indicate that these pipelines were flushed with rinse water after each waste discharge (RHO-RE-EV-46P), which would significantly reduce the potential for hazardous residues in the pipeline. There is no reason to believe that these pipelines leaked significant volumes of waste, based on process history.

2.4.2.2 241-Z-361 Settling Tank

The 241-Z-361 Settling Tank is an underground, steel-lined, concrete tank located south of the 234-5Z Building. It served as a settling tank for liquid wastes from the 234-5Z, 236-Z, and 242-Z Buildings via the 241-Z Building and the 241-Z-RB Retention Basin. The liquid wastes from the settling tank were routed through the 216-Z-1, 216-Z-2, and 216-Z-3 Cribs to the 216-Z-1A Tile Field, and to the 216-Z-12 and 216-Z-18 Cribs. This tank has been characterized and evaluated in the 241-Z-361 Tank EE/CA (DOE/RL-2003-52) and assigned to the 200-PW-1 OU for remediation. This analysis is concerned with the pipelines that carried waste to and from the settling tank. This tank contains about 29 kg (64 lbs) of plutonium.

2.4.2.3 241-Z Vault Tanks

The 241-Z Vault Tanks received and treated corrosive liquid waste from the 232-Z, 234-5Z, 236-Z and 242-Z Buildings. A common underground concrete pipe trench housed multiple stainless steel lines from the south side of the 234-5Z Building to the 241-Z Facility; the pipe trench was later replaced by several double-walled, encased pipelines. Corrosive liquid waste was treated at the 241-Z Facility to increase the pH of the liquid by the addition of soda ash in the early years, and subsequently with caustic soda. After treatment, wastes were routed to the 216-Z-1, 216-Z-2, and 216-Z-3 Cribs and then to the 216-Z-1A Tile Field, or through Diversion Boxes No. 1 & 2 to the 216-Z-12 and 216-Z-18 Cribs. In 1973, discharges to ground of contaminated water ceased and effluent from the 241-Z Treatment Facility was routed to the 244-TX Receiver Tank, and then transferred to various tank farms.

There also is the potential for contaminated soils, associated with leaks from tanks and piping, beneath the concrete vault that houses the 241-Z tanks.

2.4.3 Liquid Waste Disposal Sites

A variety of liquid waste disposal sites (e.g., cribs, French drains, and trenches) received low-level waste for disposal from PFP processes. Waste disposal sites that are outside of the scope of this analysis are mentioned here for context only as waste was routed to them via buried pipelines that are within the scope of this analysis. The following waste disposal sites are included in this discussion in order to understand the hazard potential associated with the relevant pipelines and French drains:

- 216-Z-1A Tile Field
- 216-Z-1D/216-Z-11/216-Z-19 Ditch and 216-Z-20 Crib
- 216-Z-1 Crib
- 216-Z-2 Crib
- 216-Z-3 Crib
- 216-Z-8 French Drain
- 216-Z-9 Crib
- 216-Z-12 Crib
- 216-Z-13 French Drain
- 216-Z-14 French Drain
- 216-Z-15 French Drain
- 216-Z-18 Crib
- Miscellaneous Units.

2.4.3.1 216-Z-1A Tile Field

The 216-Z-1A Tile Field is located approximately 152.5 m (500 ft) south of the 234-5Z Building and immediately south of the 216-Z-1 and 216-Z-2 Cribs. The 216-Z-1A Tile Field operated from June 1949 to April 1969. The unit originally received liquid waste overflow from the 216-Z-1 and 216-Z-2 Cribs. In later years, liquid waste was routed directly to the tile field. This site is being evaluated as part of the 200-PW-1 OU.

2.4.3.2 216-Z-1D/216-Z-11/216-Z-19 Ditch and 216-Z-20 Crib

The 216-Z-20 Crib is located south of the 216-Z-1A Tile Field and replaced the 216-Z-1D/216-Z-11/216-Z-19 Ditch sequence in 1981. The trenches were each backfilled as they were replaced. These facilities received process cooling water and steam condensate from the 231-Z, 234-5Z, and 291-Z Buildings. As noted, the contamination levels associated with these waste streams were generally quite dilute.

These waste sites received low-level waste effluent from a common, 38 cm (15 in.) diameter vitrified clay pipe process waste line from buildings within the PFP protected area. Although there was no significant inventory that was routinely discharged through these lines, the ditch bottom sediments from the predecessors to the 216-Z-20 Crib contain americium-241, cesium-137, plutonium-239, and plutonium-240. This pipeline was retained for analysis because of the concerns associated with the vitrified clay pipeline potential to retain some radionuclides. The vitrified clay pipe is more fragile that stainless or ductile iron pipeline, so it would be more prone to leaks. In addition, the vitrified clay pipe is larger diameter than the metal pipelines, so there is a greater potential for pipeline collapse, resulting in higher potential for infiltration and hazards associated with the collapse. These waste discharge sites are being evaluated as part of the 200-CW-5 OU.

2.4.3.3 216-Z-1 and 216-Z-2 Cribs

The 216-Z-1 and 216-Z-2 Cribs are located approximately 122 m (400 ft) south of the 234-5Z Building, within the overall structure of the 216-Z-1A Tile Field, near its north end. The cribs received liquid process waste from the 234-5Z Building via the 241-Z Building from June 1949 until June 1952. They also received aqueous and organic wastes from the PRF for one month in 1966 and one month in 1967. The cribs received PRF process waste and americium recovery line wastes from the 236-Z and 242-Z Buildings from March 1968 to April 1969. From March 1968 to April 1969, the cribs also received uranium wastes from the 236-Z Building (PNL-6456, *Hazard Ranking System Evaluation of CERCLA Inactive Waste Sites at Hanford*). Pipelines from the 241-Z Building to the 241-Z-361 Settling Tank transferred waste from the 234-5Z Building to these cribs. As noted above, effluent from these cribs cascaded to the 216-Z-1A Tile Field. These sites are being evaluated as part of the 200-PW-1 OU.

2.4.3.4 216-Z-3 Crib

The 216-Z-3 Crib is located approximately 122 m (400 ft) south of the 234-5Z Building, and due east of the 216-Z-1 and 216-Z-2 Cribs. The 216-Z-3 Crib also is within the footprint of the 216-Z-1A Tile Field. The 216-Z-3 Crib received neutral/basic process waste and analytical and development laboratory wastes from the 234-5Z Building via the 241-Z Building and the 241-Z-361 Settling Tank from June 1952 to March 1959. This site is being evaluated as part of the 200-PW-1 OU.

2.4.3.5 216-Z-8 French Drain

The 216-Z-8 French Drain is located 41.5 m (300 ft) east of the 234-5Z Building and 61 m (200 ft) south of 19th Street. The unit received neutral to basic RECUPLEX process waste via the adjacent 241-Z-8 Settling Tank between July 1955 and April 1962. A pair of stainless steel pipes carried the waste from RECUPLEX to the 241-Z-8 Settling Tank. This site is being evaluated as part of the 200-PW-6 OU.

2.4.3.6 216-Z-9 Crib

The 216-Z-9 Crib is located approximately 213 m (700 ft) west of the 234-5Z Building and 152 m (500 ft) south of 19th Street. The 216-Z-9 Crib operated from June 1955 to June 1962, receiving solvent and aqueous wastes from the RECUPLEX Facility in the 234-5Z Building.

Two stainless steel pipelines carried waste to the 216-Z-9 Crib. Procedures for the RECUPLEX indicate that waste to the 216-Z-9 Crib was pH-adjusted to minimize solids precipitation prior to discharge. In addition, the procedure required that the line be flushed with rinse water after every load was sent to the crib. These requirements suggest a limited potential for residual waste to be present in the pipeline to the 216-Z-9 Crib. There are no records that indicate any significant leaks from this pipeline. A remote camera survey was completed in 1993 of portions of these pipelines. Although the survey did not indicate breaks or major cracks in the pipes, both lines exhibited areas of severe pitting and corrosion. It could not be determined whether the pitting broke through the pipe walls. Small holes could have created a pathway for leakage, but the volume would have been minimal (WHC-SD-NR-ER-103, *Final Report for the Remote CCTV Survey of Abandoned Process Effluent Drain Lines 840 and 840D in Support of the 200 West Area Carbon Tetrachloride Era*). Studies performed as part of the investigation of the dispersed carbon tetrachloride vadose zone plume did not find evidence of leakage in the pipeline leading to the 216-Z-9 Crib (CP-13514, *200-PW-1 Operable Unit Report on Step 1 Sampling and Analysis of the Dispersed Carbon Tetrachloride Vadose Zone Plume*). This site is being evaluated as part of the 200-PW-1 OU.

2.4.3.7 216-Z-12 Crib

The 216-Z-12 Crib is located approximately 122 m (400 ft) southwest of the 234-5Z Building. The crib received PFP process waste and analytical and development laboratory waste from the 234-5Z Building via the 241-Z-361 Settling Tank from 1959 to 1973. The slightly acidic, low-salt waste was adjusted to a pH range of 8 to 10 before disposal. A stainless steel pipeline located inside the PFP fence line carried waste to this crib via the Diversion Box No. 2. In July 1968, because the original pipeline was plugged, a replacement pipe was run parallel to and 9.2 m (30 ft) west of the original pipeline (RHO-LD-114, *Existing Data on the 216-Z Liquid Waste Sites*). The replacement pipe bypassed 30 m (100 ft) of the original pipeline. Because there is a record of plugging in this pipe, there is a greater potential for residues in this pipe than the others considered in this analysis. This site is being evaluated as part of the 200-PW-1 OU.

2.4.3.8 216-Z-13 French Drain

The 216-Z-13 French Drain is a non-contact wastewater management unit located 58.0 m (190 ft) south of the 234-5Z Building on the southeast side of the 291-Z Building. The 216-Z-13 French Drain consists of two, 90 cm (36 in.) diameter tile culverts stacked on end in a 4.6 m (15 ft) deep, gravel-filled excavation. The unit received steam condensate from the ET-8 exhaust fan turbine and floor drainage from the 291-Z Building.

The site is reported in the Waste Information Data Systems (WIDS) as a radiological hazard. No releases of hazardous materials or radionuclides have been reported for this unit; however, due to the possibility of accidents or unusual events in the process areas, RHO-LD-114 reported that low-level contamination can be assumed (DOE/RL-91-58). This French drain is in close physical proximity to the building slabs addressed by this analysis. Therefore, this site has been retained in this analysis. This site is part of the 200-MW-1 OU.

2.4.3.9 216-Z-14 French Drain

The 216-Z-14 French Drain is a non-contact wastewater management unit located 58.0 m (190 ft) south of the 234-5Z Building on the southwest side of the 291-Z Building. The 216-Z-14 French Drain consists of two, 90 cm (36 in.) diameter tile culverts stacked on end in a 4.6 m (15 ft) deep, gravel-filled excavation. The unit received steam condensate from the ET-9 exhaust fan turbine and floor drainage from the 291-Z Building.

Trace beta activity has been reported for the 216-Z-14 French Drain (DOE/RL-91-58), and the site is reported in WIDS as a radiological hazard. No releases of hazardous materials or radionuclides have been reported for this unit; however, due to the possibility of accidents or unusual events in the process areas, RHO-LD-114 reported that low-level contamination can be assumed (DOE/RL-91-58). This French drain is in close physical proximity to the building slabs addressed by this analysis. Therefore, this site has been retained in this analysis. This site is part of the 200-MW-1 OU.

2.4.3.10 216-Z-15 French Drain

The 216-Z-15 French Drain is a non-contact wastewater management unit located approximately 6.1 m (20 ft) south of the 234-5Z Building on the north side of the 291-Z Building. The 216-Z-15 French Drain consists of two, 90 cm (36 in.) diameter tile culverts stacked on end in a 4.6 m (15 ft) deep, gravel-filled excavation. The unit received steam condensate from the S-12 evaporator cooler.

The site is reported in WIDS as a radiological hazard. No releases of hazardous materials or radionuclides have been reported for this unit; however, due to the possibility of accidents or unusual events in the process areas, RHO-LD-114 reported that low-level contamination can be assumed (DOE/RL-91-58). This French drain is in close physical proximity to the building slabs addressed by this analysis. Therefore, this site has been retained in this analysis. This site is part of the 200-MW-1 OU.

2.4.3.11 216-Z-18 Crib

The 216-Z-18 Crib is located approximately 183 m (600 ft) south of the 234-5Z Building. The 216-Z-18 Crib received wastes from the 236-Z Building. The inlet pipeline to this crib is the same pipeline that is used by 216-Z-1A Tile Field and then branches out to the 216-Z-1, 216-Z-2, and 216-Z-18 Cribs. Only the inlet pipeline will be included in this analysis.

The crib received both extraction column solvent and acidic aqueous waste from the PRF in the 236-Z Building from April 1969 to May 1973. The 216-Z-18 Crib is being evaluated as part of the 200-PW-1 OU.

2.4.3.12 Miscellaneous Units

Records for PFP indicate a number of shallow miscellaneous disposal units (e.g., injection wells) around the buildings. These sites received steam and HVAC condensate, as well as water from eyewash stations and other generally non-process sources. Those miscellaneous units that received streams from the 291-Z and 241-Z Buildings are considered to be potentially contaminated because of known contamination at these locations and, therefore, are within the scope of this analysis. Records indicate that the remaining miscellaneous units at PFP generally received steam condensate and other sources derived from potable water or storm water.

2.4.4 Septic Tanks and Drain Fields

Septic tanks and drain fields at PFP do not have a history of contamination. These sites are reported as having received only sanitary wastes. Although no sampling data are reported in DOE/RL-91-58 for the septic tanks, radiological and chemical contaminants from PFP are not suspected at these locations. Although it can not be stated conclusively that no hazardous waste was sent to these sites, the risk associated with any such discharge would be minimal. Neither these septic tanks, drain fields, nor pipelines to the septic tanks are in the scope of this analysis. The following septic tank and drain field sites have been assigned to the 200-ST-1 OU for final remediation:

- 2607-WA Septic Tank
- 2607-WB Septic Tank
- 2607-W8 Septic Tank
- 2607-Z Septic Tank and Drain Field
- 2607-Z-1 Septic Tank and Drain Field
- 2607-Z8 Septic Tank.

2.4.5 Pipelines and Diversion Boxes

Process waste transfer pipelines connect the major processing facilities with each other and with the various waste disposal and storage facilities. Process waste transfer pipelines generally are stainless steel pipes with welded joints, ranging from approximately 3.8 to 20 cm (1.5 to 8 in.) in diameter. Although some wastewater pipelines were constructed of a variety of materials, including vitrified clay that ranged up to approximately 38 cm (15 in.) in diameter, process waste routinely was carried in stainless steel piping. The pipelines are generally enclosed in secondary containment encasement piping or steel-reinforced, concrete encasements and are set in the sub-grade, although some are direct-buried. Though the majority of the waste disposal facilities themselves are addressed through various processes, these pipelines are the focus of much of this analysis.

Various process pipelines ran from the 234-5Z Building to the 216-Z-1 and 216-Z-2 Cribs, the 216-Z-1A Tile Field, 216-Z-3 Crib, 216-Z-12 Crib, and the 216-Z-18 Crib. These pipelines generally were routed through the 241-Z Treatment Facility and the 241-Z-361 Settling Tank prior to transfer to a crib or tile field. Dedicated pipelines from RECUPLEX drained to the 241-Z-8 Settling Tank, the 216-Z-8 French Drain, and the 216-Z-9 Crib.

Non-contact wastewater exited the 234-5Z Building through vitrified clay pipelines, which initially discharged to the 216-Z-1D/216-Z-11/216-Z-19 Ditch system. This ditch system ultimately was replaced with the 216-Z-20 Crib. Near the 234-5Z Building, additional non-contact wastewater was discharged through French drains (216-Z-13, 216-Z-14, and 216-Z-15) located around the 291-Z Building. As noted above, although non-process wastewater would not contain sufficient contamination to present a threat to human health and the environment, the French drains are reported as having received contaminated effluent and will be included in this analysis as listed in Table 1-1.

Wastewater sources with a high potential for contamination have either been replaced with a closed loop cooling system or eliminated. The remaining wastewater sources that may contain contamination now are sent to the 243-Z Low-Level Waste Treatment Facility; the treated wastewater is discharged to the Treated Effluent Disposal Facility (TEDF).

The PFP wastewater sewer system disposes of nonhazardous wastewater to the TEDF. Physical and administrative controls are in place to reduce the possibility of contamination from radioactive or hazardous materials and to prevent discharge above release levels established by DOE (Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards*), Ecology (WAC 173-303, *Dangerous Waste Regulations),* the Project Hanford Management System, and the *200 Area Treated Effluent Disposal Facility Interface Control Document* (HNF-SD-W049H-ICD-001).

The effluent carried by pipelines to the cribs and trenches south of the 234-5Z Building was directed to specific disposal sites through diversion boxes, which are described below.

2.4.5.1 241-Z Diversion Box No. 1

The Diversion Box No. 1 is associated with the 234-5Z liquid waste disposal cribs. It is located approximately 100 m (328 ft) south of the 234-5Z Building and approximately 10 m (33 ft) north of the 216-Z-1A Tile Field. It is buried to a depth of 2.7 m (9 ft) with the upper surface of its 0.15 m (0.5 ft) thick lid slightly above ground level. A floor drain within the unit discharges to the soil column approximately 15 m (50 ft) southeast of the unit. Multiple encased liquid waste transfer pipelines enter the box through its north wall. Liquid waste routing is made possible through the use of changeable jumper assemblies that connect pairs of waste transfer pipelines. Process wastes from the 232-Z, 234-5Z, 236-Z and 242-Z Buildings were routed to this diversion box via the 241-Z Building and the 241-Z-361 Settling Tank. Two stainless steel transfer pipelines connect the unit to the 216-Z-1 Crib and the 216-Z-3 Crib. A third stainless steel pipeline runs to the Diversion Box No. 2.

2.4.5.2 241-Z Diversion Box No. 2

The Diversion Box No. 2 is associated with the 234-5Z liquid waste disposal cribs. It is located approximately 100 m (328 ft) southwest of the 234-5Z Building and approximately 10 m (33 ft) north of the 216-Z-12 Crib. It is buried to a depth of 5.2 m (17 ft) with the upper surface of its 0.15 m (0.5 ft) thick lid slightly above ground level. A floor drain within the unit discharges to the soil column approximately 15 m (50 ft) northwest of the unit. Multiple encased liquid waste transfer pipelines enter the box through its east wall. Liquid waste routing is made possible through the use of changeable jumper assemblies that connect pairs of waste transfer pipelines.

Process wastes from the 232-Z, 234-5Z, 236-Z and 242-Z Buildings were routed to this diversion box via the 241-Z Building and the 241-Z-361 Settling Tank through the Diversion Box No. 1. Two stainless steel transfer pipelines connect the diversion box to the 216-Z-12 Crib.

2.4.6 Unplanned Releases

There are several PFP unplanned releases (UPRs) documented in WIDS. Of these, UPR-200-W-23 (200-UR-1 OU) and UPR-200-W-103 (200-PW-1 OU) appear to be the only releases that may present an ongoing concern associated with sub-grade contamination. UPR-200-W-23 occurred in June 1953, due to a fire in a waste box near the 234-5Z Building. It contaminated approximately 28 m^2 (300 ft^2) of ground. Plutonium contamination resulted in readings up to 10,000 dpm. UPR-200-W-103 resulted from a pipeline release that occurred in April 1971, in a pipeline between the 234-5Z Building and the 216-Z-18 Crib. The UPR is located near the southeast corner of the 236-Z Building and contained approximately 10 grams (0.35 oz) of plutonium with gross alpha contamination >6,000,000 dpm.

In addition to the documented UPRs, potential leaks from direct buried piping or from underground trenches may have contaminated soils beneath building slabs. In February 1969, a waste pipeline from the 234-5Z Building to the 241-Z Building failed in the buried concrete pipe trench and resulted in the release to soil of approximately 11,400 L (3,000 gal) of waste. The pipeline was welded and returned to service. This spill has not been recorded as an UPR within WIDS and is not well characterized. In the 234-5Z Building, process pipelines exit the building through the building slab and run horizontally for some distance either direct buried or in underground trenches before re-entering the building at the below-grade pipe tunnels level. As some of the underground trenches are contaminated and have been sealed, the potential exists that some of these single-wall pipes may have leaked into the soils beneath the slab.

2.5 SOURCE, NATURE, AND EXTENT OF CONTAMINATION

This section describes the sources of contaminants discharged as a result of plutonium processing operations at PFP, lists the hazardous constituents of concern, and describes the extent of contamination in the sub-grade through process operations records and models.

The process history of PFP operations is used to describe the chemical and radiological constituents discharged in liquid effluent streams through the various PFP sub-grade installations. This information is provided in D&D-30349, which describes PFP liquid effluents including processes that resulted in the discharge of liquid effluent containing hazardous constituents through the PFP buried pipelines. It describes the hazardous constituents resulting from the individual processes and found in these waste streams. The stabilization of plutonium forms that resulted in contaminant deposits in below-grade ducting are not included specifically in this study but are bounded by the constituents of concern described in the individual PFP processes. Additionally, analytical data are provided from the sampling and analysis of the 241-Z-361 Settling Tank. PFP process waste except for the RECUPLEX waste streams from the 234-5Z process are represented in the 241-Z-361 Settling Tank sludge. However, the RECUPLEX hazardous constituents are also represented in the 241-Z-361 Settling Tank as essentially the same process and chemicals were used at the 236-Z PRF. The PRF replaced the RECUPLEX operation in 1964. PRF processes were the same chemically as the RECUPLEX processes in 234-5Z Building except for the use of DBBP in the 242-Z Waste Treatment process.

PRF and 242-Z Building wastes were routed to the 241-Z-361 Settling Tank before being discharged to the various cribs (D&D-30349).

The processes contributing hazardous constituents included effluent streams from the following:

- PFP Process Operations: 234-5Z Rubber Glove, RMA line, RMC line, and RECUPLEX wastes generated included hydrofluoric, oxalate, and nitric acids, plutonium and other transuranic metals and heavy metals. Organic wastes included carbon tetrachloride, TBP, and DBBP. Very small quantities of sulfuric acid were occasionally used.

- 242-Z Waste Treatment and Americium Recovery Facility: Generated hydrochloric, hydrofluoric, phosphoric, and nitric acids; plutonium, americium, metals and organics such as TBP, DBBP and carbon tetrachloride.

- PRF or 236-Z Building: Processes used nitric and hydrofluoric acids, aluminum nitrate, hydroxyl amines, and organics, primarily carbon tetrachloride and TBP, and generated wastes which included organics, metals, and transuranics.

- Laboratory operations: Generated laboratory wastes containing organic (including acetone), radioactive and metal constituents.

Background information on PFP process effluents discharged to specific cribs, ponds and ditches in the PFP Facility complex is provided in DOE/RL-2001-01. DOE/RL-2001-01 further describes activities planned to investigate the primary chemical hazardous constituent discharged at PFP which is carbon tetrachloride. Carbon tetrachloride is the major constituent of a dense non-aqueous phase liquid plume which is the subject of continuing investigation in the vadose zone around and beneath the PFP Facility as part of the investigations of the dispersed carbon tetrachloride vadose zone plume (CP-13573 *Data Quality Objectives Summary Report for Investigation of Dense, Nonaqueous-Phase Liquid Carbon Tetrachloride in the 200 West Area* and DOE/RL-2001-01, Appendices C and D). Also included are preliminary conceptual contaminant distribution models on the nature and extent of contamination and a strategy for developing and managing a remediation strategy for carbon tetrachloride contamination.

DOE/RL-91-58 includes an assessment of the various constituents of concern that were discharged as liquid waste streams to cribs, ponds, ditches, and other liquid waste facilities at PFP.

Hazardous constituents of concern for this analysis include radionuclides, organic chemicals, and heavy metals. Key radionuclide contaminants are transuranic including various plutonium isotopes (plutonium-238 through plutonium-240) and their decay products (americium-241, uranium isotopes uranium-234 through uranium-238, and neptunium-237), and lesser amounts of radioactive corrosion and fission products (e.g., cobalt-60, strontium-90, technetium-99 and cesium-137). The major organic chemicals contributing to PFP waste streams and resulting contamination include solutions of carbon tetrachloride, TBP, and DBBP. The major inorganic contaminants include primarily heavy metals such as lead, chromium, cadmium, mercury, and silver. Table 2-1 lists the hazardous constituents for the PFP sub-grade structures and installations, and the source that provides the rationale for their inclusion in this analysis. The rationale for inclusion of hazardous constituents is based on historical process information, a study of actual process records and chemical flow sheets (D&D-30349) and sampling and analysis results from the 241-Z tank characterization and from borehole samples from two boreholes with the fence line of PFP.

Table 2-1. Hazardous Constituents for the PFP Sub-Grade. (3 pages)

CASRN[1] Number	Hazardous Constituents	Rationale[2,3]
	Metals and Inorganics	
7440-38-2	Arsenic	D&D-30349 HNF-8735
133-22-14	Asbestos (transite piping)	D&D-30349
7429-90-5	Aluminum	D&D-30349 HNF-8735
7440-39-3	Barium	HNF-8735
7440-41-7	Beryllium	D&D-30349 HNF-4225
7440-48-4	Cobalt	HNF-4225
7440-50-8	Copper	HNF-4225
7440-43-9	Cadmium	HNF-30349 HNF-8735
7440-47-3	Chromium	D&D-30349 HNF-8735 SIM (216-Z-20)
18540-29-9	Chromium (IV)	HEIS
57-12-5	Cyanide	D&D-30349
16887-00-6	Chloride	DOE/RL-91-58 SIM (216-Z-1&2, 216-Z-3)
16984-48-8	Fluoride	D&D-30349
7439-92-1	Lead	D&D-30349 HNF-8735 SIM (216-Z-1&2, 216-Z-3)
7439-97-6	Mercury	D&D-30349 HNF-8735
7440-02-0	Nickel	D&D-30349 HNF-8735
14797-55-8	Nitrite	DOE/RL-91-58
7440-23-5	Sodium (from NaOH)	D&D-30349 HEIS
14808-79-8	Sulfate	D&D-30349
7440-22-4	Silver	D&D-30349 HNF-8735
7440-61-1	Uranium	D&D-30349 HNF-8735 SIM (216-Z-1 &2, 216-Z-3)
7440-66-6	Zinc	HNF-8735 DOE/RL-91-58
Radionuclides		
14596-10-2	Americium 241	HNF-30349 HNF-8735 SIM (216-Z-1&2, 216-Z-3)
14993-75-0	Americium 243	SIM (216-Z-1&2, 216-Z-3)
10198-40-0	Cobalt 60	HEIS SIMS (216-Z-1&2)
10045-97-3	Cesium 137	SIMS (216-Z-1&2, 216-Z-3

Table 2-1. Hazardous Constituents for the PFP Sub-Grade. (3 pages)

CASRN[1] Number	Hazardous Constituents	Rationale[2,3]
		)RHO-LD-114
10098-97-2	Strontium 90	D&D-30349 HNF-8735 SIM (216-Z-1&2, 216-Z-3)
14133-76-7	Technetium-99	D&D-30349 HNF-8735 SIM (216-Z-1&2, 216-Z-3)
13994-20-2	Neptunium 237	HNF-30349 HNF-8735 SIM (216-Z-1&2, 216-Z-3)
13981-16-3	Plutonium 238	HNF-8735 SIM (216-Z-1&2, 216-Z-3)
15117-48-3	Plutonium 239	HNF-4225 HNF-8735 SIM (216-Z-1&2, 216-Z-3)
14119-33-6	Plutonium 240	HNF-8735 SIM (216-Z-1&2, 216-Z-3)
14119-32-5	Plutonium 241	SIM (216-Z-1&2, 216-Z-3)
13982-10-0	Plutonium 242	SIM (216-Z-1&2)
13982-63-3	Radium 226	HEIS
15262-20-1	Radium 228	HEIS
14133-76-7	Technetium 99	HNF-30349 SIM (216-Z-1&2, 216-Z-3)
14274-82-9	Thorium 228	HEIS
7440-29-1	Thorium 232	HEIS
7440-61-1	Uranium 238	HNF-8735
13968-55-3	Uranium 233	HNF-4225
15117-96-1	Uranium 235	HNF-8735 SIM (216-Z-1&2)
Organic Chemicals		
67-64-1	Acetone	D&D-30349 HNF 8735 Sanders 2000
67-63-0	Alcohol	HNF-4225
71-43-2	Benzene	HNF-4225
71-36-3	1-Butanol	HNF- 8735 Sanders 2000
56-23-5	Carbon Tetrachloride	HNF-4371 HNF-8735 SIM (216Z-1&2, 216-Z-3) DOE/RL-91-58
67-66-3	Chloroform	Sanders 2000
78-46-6	Dibuty butyl phosphonate (DBBP)	D&D-30349
107-66-4	Dibutyl phosphate(DBP)	D&D-30349
75-71-8	Dichlorodifluoromethane	HNF-4225
96-37-7	Methylcyclopentane	HNF-4371
75-09-2	Methylene Chloride	HNF-8735 DOE/RL-91-58
1336-36-3	Polychlorinated Biphenyls	D&D-30349 HNF-8735
25167-20-8	Tetrabromoethane	HNF-4225
127-18-4	Tetrachloroethylene	HNF-4225

Table 2-1. Hazardous Constituents for the PFP Sub-Grade. (3 pages)

CASRN[1] Number	Hazardous Constituents	Rationale[2,3]
		HNF-4371 Sanders 2000
79-01-6	Trichlorethylene	HNF-4225 HNF-4371
126-73-8	Tributyl phosphate (TBP)	D&D-30349 SIM (216Z-1&2)
108-88-3	Toluene	HNF-4225
8016-28-2	Lard Oil	D&D-30349 HNF-4225 DOE/RL-91-58
68153-81-1	Oil/grease	HEIS
75-09-2	Dichloromethane	Sanders 2000
106-97-8	N-Butane	Sanders 2000
75-69-4	Freon 11	Sanders 2000
106-66-0	N-Pentane	Sanders 2000
107-83-5	2-Methyl Pentane	Sanders 2000
1330-20-7	Xylene	HNF-4225

1 Chemical Abstracts Service Registry Number

2 HEIS = Hanford Environmental Information System (soil data from boreholes 299-W15-42 and 299-W15-764)
SIM = Soil Inventory Model

3 D&D-30349, 2006, *Study of Liquid Effluents and CERCLA Hazardous Constituents Generated and Discharged by the Plutonium Finishing Plant*, D. Lini and A. Hopkins, Rev. 0, Fluor Hanford, Richland, Washington.
DOE/RL-91-58, *Z-Plant Source Aggregate Area Management Study Report*, Rev. B, October 1992, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
HNF-4225, *241-Z-361 Sludge Characterization Data Quality Objectives*, March 1999, Environmental Quality Management for BWHC, Richland, Washington.
HNF-4371, *241-Z-361 Sludge Characterization Sampling and Analysis Plan*, June 29, 2999, Environmental Quality Management for Fluor Hanford, Richland, Washington.
HNF-8735, *241-Z-361 Tank Characterization Report*, Rev. 0, June 29, 2001, Environmental Quality Management for BWHC, Richland, Washington.
Sanders, 2000, Letter, George H. Sanders (RL) to Douglas R. Sherwood (EPA), *Completion of Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Plutonium Finishing Plant (PFP) Project Interim Milestone M-15-37B*, dated May 31, 2000. Appendix A--Validated Data Packages and Recommendations for Regulatory Path Forward for Remediation of Tank 241-Z-361.

Residual quantities of hazardous chemicals and radionuclides may remain as hold-up or as heels in buried pipelines, or in contaminated soils. Records indicate that the process waste pipelines from RECUPLEX to the 241-Z-8 Settling Tank, 216-Z-8 French Drain, and the 216-Z-9 Crib were flushed with clean water after each use (HW-35030). In addition, the replacement D-8 process waste pipelines associated with the 241-Z Facility, including the pipelines to tank farms, were flushed as part of RCRA closure (HNF-30205). Although some additional pipelines may have been drained, there is little documentation indicating which pipelines have been flushed; therefore, residues may be present in some pipelines. Because PFP processes involved some amount of plutonium, chemical contamination likely will exist only in the presence of plutonium.

Leaks from sub-grade piping could have resulted in soil contamination. Historically, piping was subject to corrosive solutions, heat stress from steam jetting, and corrosion protection systems that later proved unreliable. Large volumes of organic compounds from PFP were disposed to the ground through cribs, trenches, and tile fields. These sites are being evaluated as part of various OUs surrounding PFP (e.g., 200-PW-1, 200-PW-3, 200-PW-6 in DOE/RL-2001-01) to identify sources of contamination contributing to vadose zone and groundwater plumes. Organic process chemicals that leaked from the pipelines to these disposal facilities are not likely to pose a sufficient threat to human health or the environment to justify consideration for an action independent of the activities being pursued by current and planned remedial activities. Surveys of the near-surface soils to date have not identified significant concentrations of volatile organic chemicals adjacent to the PFP process pipelines found outside the security fence (CP-13514).

In addition to process waste, an unspecified volume of generally dilute non-process and non-contact process water was discharged to disposal fields and trenches (D&D-30349). Any residues in the piping that are soluble in water were likely to have been dissolved and washed through the piping to the disposal site. Where steam-jetting was used for transfer (e.g., to/from 241-Z-361), compounds with low boiling points and high vapor pressures would likely have been vaporized and released through risers and vents.

Early tests showed that liquid wastes from PFP processes that were disposed to cribs exhibited better plutonium adsorption in soil when the solution was slightly acidic (pH <3) (HW-32033, *Reduced Neutralization of 231, 234-5 Crib Wastes*). Studies have been conducted at several of the discharge sites that received PFP wastes to determine the nature and extent of soil contamination. Some historical studies are summarized below:

- ***Distribution of Plutonium and Americium Beneath the 216-Z-1A Crib: A Status Report***, RHO-ST-17. The 216-Z-1A Tile Field, at times referred to as a crib, received approximately 1 million L (264,000 gal) of waste effluent from the 216-Z-1, 216-Z-2, and 216-Z-3 Cribs between 1949 and 1959. Between 1964 and 1969, the tile field received an estimated 6 million L (1,584,000 gal) of neutralized acidic waste liquid from 234-5Z, containing approximately 57 kg (125.7 lbs) of plutonium. The highest concentrations of plutonium (4 x 104 nCi/g) and americium (2.5 x 103 nCi/g) occur in sediments immediately beneath the tile field, below the central distributor pipe. The estimated lateral spread is within a 10 m (33 ft) wide zone, encompassing the perimeter of the tile field. Concentration generally decreases with depth, except for an observed increase where higher silt content occurs in sediments or at boundaries between sedimentary units. The bulk of actinide contamination appears to be within the first 15 m (49 ft) of sediments beneath the crib.

- ***216-Z-8 French Drain Characterization Study***, RHO-RE-EV-46P. The 216-Z-8 French drain received overflow from the 241-Z-8 Settling Tank (approximately 58,500 L [15,444 gal]); waste was dilute and nearly neutral in pH. The tank was taken out of service in 1962. It is estimated that 9,590 L (2,532 gal) of liquid waste (plus rinse water) containing an estimated 48.2 g (1.7 oz) of plutonium overflowed from the settling tank to the French drain. Plutonium and americium activity attributed to the waste discharged to the French drain was encountered in a zone extending approximately 5 m (16 ft) from the bottom of the French drain. An estimated 1 m (3 ft) deep zone of >10 nCi/g activity may exist directly below the French drain. Plutonium activity was shown to have decreased rapidly with distance from the bottom of the French drain.

- ***216-Z-9 Crib History and Safety Analysis***, ARH-2207. The crib received approximately 3.8 million L (1 million gal) of wastes, which contained 27.4 kg (60 lb) of plutonium, by accountability records (1955-1962). Soils were sampled in seven locations at up to 2 m (6 ft) below the crib floor. The highest concentration of plutonium measured was 34.5 g/L of soil at a depth of 0 to 15 cm (0 to 6 in.) beneath the crib floor. Based on this result, the plutonium content of the crib soil is estimated at 50 to 150 kg (110 to 331 lb).

These studies indicate that most of the plutonium in waste effluent is bound to the soils close to the location of discharge. Plutonium and americium are retained in the upper few meters of the soil column and normally adsorb strongly to soil with concentrations usually higher near the area of release (DOE/RL-2001-01).

More recent documentation has been prepared characterizing the soils in and around the PFP Complex. For example, DOE/RL-2001-01 addresses the aforementioned discharge sites, and supports/amplifies the historical information:

> "Plutonium and americium typically are retained in the upper few meters of the soil column when released in a dissolved aqueous phase. Because of their large distribution coefficients, they normally adsorb strongly to Hanford sediments. As a general rule, concentrations of these contaminants usually are higher near the area of release and decrease with depth and distance from the source in the vadose zone. Elevated concentrations may be detected where finer grained sediments are present, increasing the residence time of migrating contaminants. At the 216-Z-1A Tile Field and 216-Z-9 Crib, these radionuclides also were discharged as co-contaminants with the DNAPL-complexant mixture (carbon tetrachloride mixed with tributyl phosphate), which could have enhanced the mobility of these radionuclides and resulted in higher concentrations much deeper in the vadose zone."[1]

In order to describe in a simple model the suspected extent of two unplanned releases at PFP, two figures have been developed. Figure 2-10 shows a predicted plume associated with the leak from the pipe trench between the 234-5Z Building and the 241-Z Facility; this plume was developed primarily from the observed contamination at 216-Z-8 French drain (HNF-30654). Figure 2-11 illustrates the anticipated plume of plutonium contamination associated with a leak of 150,000 L (39,600 gal) of waste from the Tank D-6 vault at the 241-Z Facility. There are no records to quantify how much liquid may have leaked at this site; this volume was used for modeling purposes only.

2.6 RISK EVALUATION

PFP sub-grade installations (e.g., pipelines and associated UPRs) potentially contain radioactive isotopes, heavy metals, and regulated organic compounds. Because the sub-grade installations are now covered by sufficient soil to shield site workers from any radiation that is present, there currently is not a significant basis for concern regarding personnel exposure. Although current site conditions do not preclude exposure of burrowing animals, historical experience and the level of activity that is anticipated in the vicinity of PFP until final remedial actions are implemented suggests that the site is not likely to become attractive to burrowing animals. Chemical hazards also are located beneath a soil cover that prevents exposure from most site activities. Ongoing investigations associated with the Hanford Site groundwater plumes are evaluating the organic contamination in the soils in and around PFP to incorporate appropriate and necessary actions into the remedial action program for those contaminants.

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[1] "DNAPL" means dense, nonaqueous phase liquid.

If piping has leaked and released contaminants to surrounding soils, there is potential for contaminant dispersion through natural precipitation, exposure to personnel during excavation associated with onsite activities, and minimal animal exposure through burrowing activity. The pipelines generally are several feet below the ground surface; however, and the soil cover would provide shielding for site personnel, absent excavation that disturbs contaminated soils. Generally, alpha contamination from leaks will be located in close proximity to pipelines and the potential for migration of these radionuclide contaminants is limited. Surveys completed thus far along pipelines via soil gas sampling of the near-surface vadose zone in support of the investigations associated with the dispersed carbon tetrachloride vadose zone plume indicate some organic contamination from pipeline leaks relative to the clay vitrified pipe.

Discharges to waste disposal sites associated with process activities at PFP provide the most significant inventories of both radionuclide and chemical contamination. These sites (e.g., 216-Z-1A, 216-Z-9, 216-Z-12) are being evaluated as part of the investigations for the relevant OUs, as shown in Attachment 1, as part of ongoing processes.

Analysis of these sub-grade installations makes effective use of the currently available site personnel who have the necessary experience and skills to assess the risk potential, and work with the radionuclides present, as needed. These individuals are most qualified to make a qualitative assessment of the risk associated with the PFP sub-grade installations.

Contamination that is present in PFP sub-grade structures (e.g., building slabs) may be more accessible to site workers and to dispersion through natural forces. Some sub-grade structures contain residual radionuclide contamination from process spills during facility operations. During the implementation of the removal action work plan for the PFP above-grade EE/CA, contamination control measures will be implemented to prevent the migration of contamination for approximately 20 years (e.g., a contamination control cap will be installed over building slabs, structures such as the 241-Z-RB Retention Basin will be filled). Because the PFP above-grade EE/CA established an endpoint of slab-on-grade, this sub-grade analysis will review the data that support the contamination control cap to determine its suitability as an interim measure for the approximately 20 years until a final measure is implemented (HNF-22401, *Plutonium Finishing Plant (PFP) Complex End Point Criteria*).

Figure 2-10. 241-Z Pipe Trench – Soil Intrusion Profile.

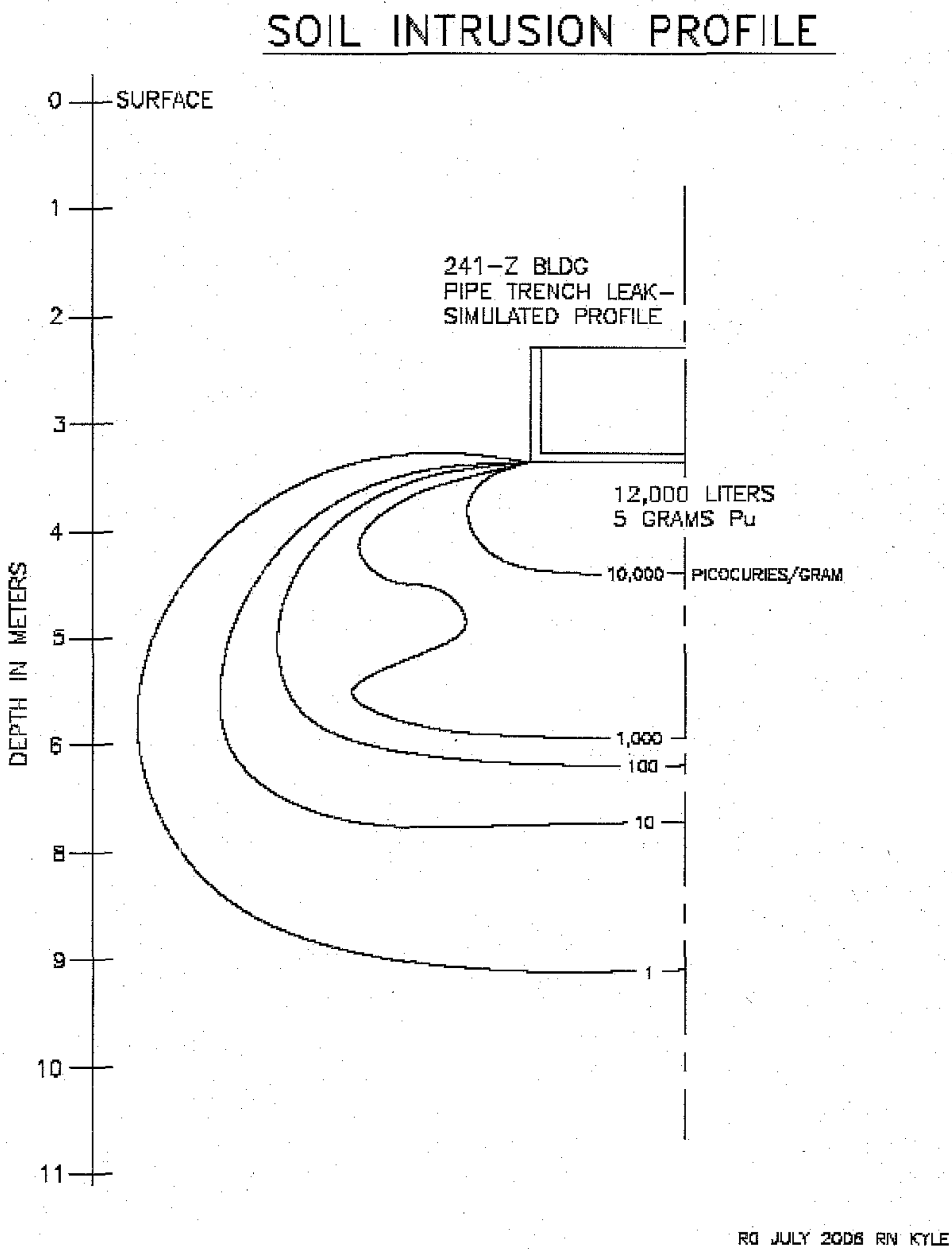
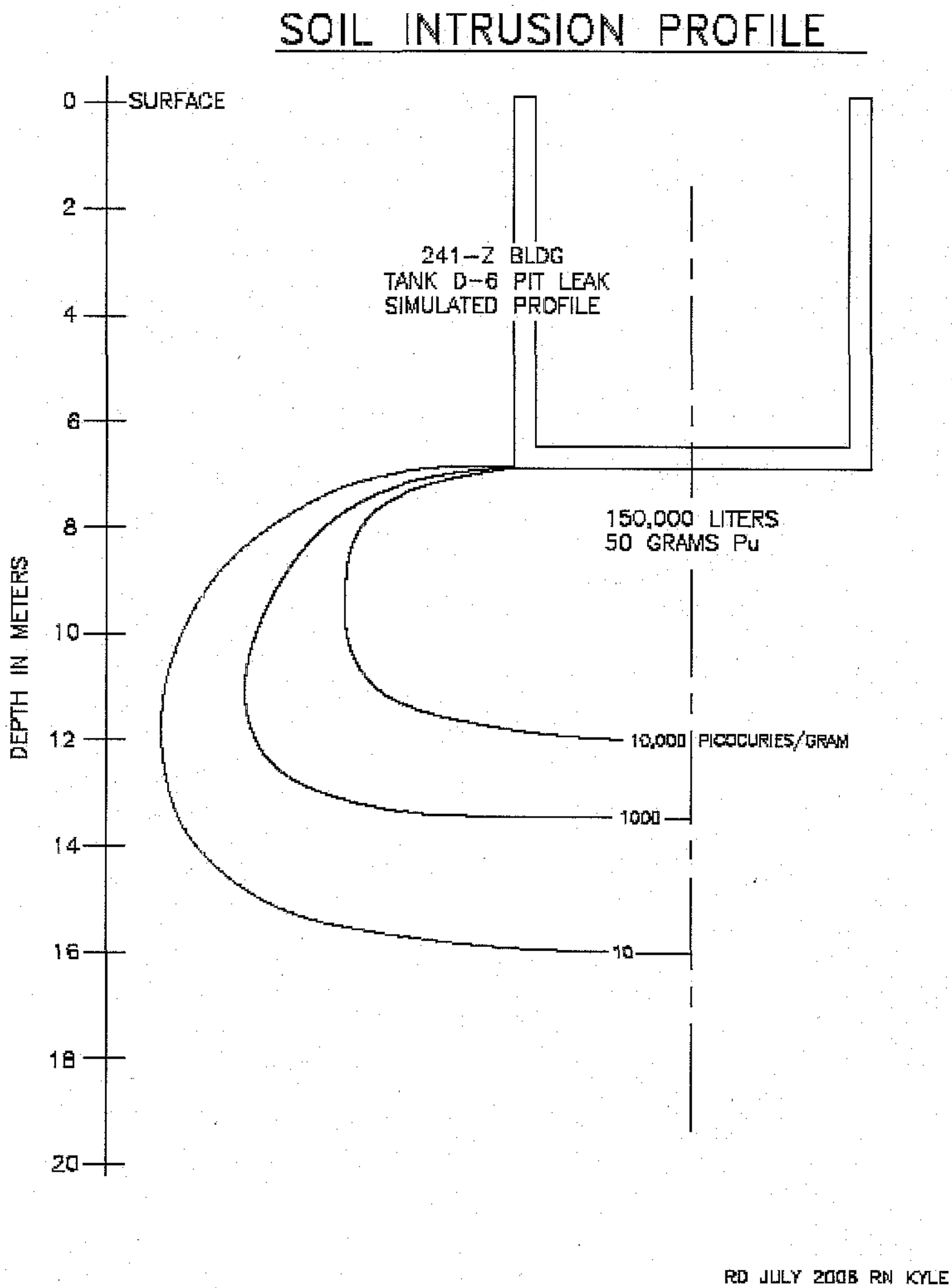


Figure 2-11. 241-Z Building – Soil Intrusion Profile.



3.0 OBJECTIVES FOR EVALUATION OF ALTERNATIVES

This chapter establishes the objectives to be attained by the alternatives evaluated for the reduction of risk associated with the PFP sub-grade structures and installations. The removal action objectives (RAOs) are media-specific or OU-specific objectives for protecting human health and the environment. They are developed considering the land use, contaminants of potential concern, potential applicable or relevant and appropriate requirements (ARARs), and exposure pathways. They can not be inconsistent with the remedial action objectives of the final selected remedy for the OU.

The RAOs are general descriptions of what the alternatives are expected to accomplish. They are defined as specifically as possible and usually address the following variables:

- Media of interest (e.g., contaminated soil, solid waste)
- Types of contaminants (e.g., radionuclides, inorganic, and organic chemicals)
- Potential receptors (e.g., humans, animals, plants)
- Possible exposure pathways (e.g., external radiation, ingestion).

The PFP sub-grade structures and installations are anticipated to contain some level of radionuclide and/or chemical contamination, as described in Chapter 2.0, which may present a risk to human health or the environment. The following RAOs are developed in the context of the overall program for the Central Plateau. The following RAOs have been identified based on the potential hazards discussed in Chapter 2.0:

- Protect human receptors from exposure to contaminants above acceptable exposure levels

- Control migration of contamination from sub-grade structures and installations into the environment

- Prevent or reduce occupational health risks to workers performing activities undertaken to reduce risks associated with the PFP sub-grade structures and installations.

- Achieve ARARs to the extent practicable

- Be consistent with anticipated future remedial actions within PFP and the OU

- Safely treat, as appropriate, and dispose of wastes generated by activities undertaken to reduce risks associated with the PFP sub-grade structures and installations.

- Minimize the general disruption of cultural resources and wildlife habitat, and prevent adverse impacts to cultural resources and threatened or endangered species.

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4.0 DISCUSSION OF ALTERNATIVES

The purpose of this section is to summarize the relevant and viable alternatives that are to be considered to reduce the risk associated with the sub-grade structures and installations of this analysis. The following four alternatives were identified for consideration:

- No Action
- Surveillance and Maintenance
- Stabilize and Leave in Place
- Remove, Treat, and Dispose.

Table 4-1 identifies which alternatives were considered for each of the PFP sub-grade structures and installations within the scope of this analysis.

The following assumptions and information contribute to the selection of alternatives:

- Flushing of pipelines is not evaluated as an alternative because prior experience at the Hanford Site suggests that flushing of contaminated waste lines could exacerbate existing contamination, particularly if the integrity of the existing piping has been compromised. In addition, collection and management of flush water can be difficult and expensive, and flushing often is not effective in meeting the intended goal.

- Although a barrier option is being considered as the final action for areas of the Central Plateau, including PFP, there is no defined ultimate end state for final remediation of the PFP. Therefore, the alternatives considered in this analysis cannot assume any specific plan for PFP site closure. Contamination control covers are installed, as necessary, over building slabs as part of the PFP above-grade structures removal action. Placement of individual barriers over remaining sub-grade structures and installations would potentially hamper the implementation of future remedial actions within PFP. Therefore, individual barrier placement was not analyzed in this analysis.

- The organic chemical contamination plume beneath PFP currently is being addressed through ongoing investigations (DOE/RL-2001-01).

- An analysis of the release potential and associated risk/threat is made on the basis of process knowledge, including waste constituents and volumes, piping materials, any known releases, and assumptions regarding leaks and spills. This information is derived from process and facility operations records.

- Alternative activities will assume removal of the top 1 m (3 ft) of soil at a UPR site, or removal of soil to a depth of 1 m (3 ft) beneath contaminated building slabs or pipelines which removes near-surface contamination, unless otherwise indicated.

- Activities recommended by the PFP above-grade structures EE/CA and the 232-Z EE/CA are implemented and include structures reduced to slab-on-grade and stabilized through the placement of a 20-year contamination control cover, as necessary, after the demolition of buildings. PFP above-grade structures and 232-Z EECA activities also assume the filling of the 232-Z sub-grade ductwork, 241-Z Retention Basin and its valve pit, the two diversion boxes, and the 243-ZA tank pit.

- A 20-year time frame was used as the interim period by this analysis until implementation of the final remedial actions at PFP to allow for a common basis for evaluating risk/benefits associated with alternatives. The actual time before remediation may be greater or less than 20 years depending on cleanup priorities.

Cost estimates were prepared by professional estimators experienced in construction, decontamination, removal, treatment, and disposal activities. Costs are presented both in constant dollars (non-discounted) and in terms of present worth (discounted). The former reflects the cost of the alternative from a viewpoint of resources required. The latter conforms to the guidance in EPA 540-R-00-002, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*. The cost estimates are relational, not absolute, costs for the comparison of the alternatives. Present-net-worth costs were estimated using the real discount rate published in Appendix C of the Office of Management and Budget *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (OMB Circular No. A-94). Present-net-worth costs are discussed for each alternative in the following sections.

The balance of this section provides a brief summary of the features of each alternative.

Table 4-1. Alternatives Considered for PFP Sub-Grade[1]. (5 pages)

Structure/Installation	Alternative 1 - No Action	Alternative 2 - Surveillance and Maintenance	Alternative 3 - Stabilize and Leave-in-Place	Alternative 4 - Remove, Treat and Dispose[2]		
				Option A – Remove all building slabs	Option B – Remove priority building slabs (236-Z, 241-Z, 242-Z, 291-Z)	Option C - Do not remove any building slabs
Contaminated Building Slabs						
232-Z	X	X	Bldg. slab stabilized as is	X	n/a	n/a
234-5Z	X	X	Bldg. slab stabilized as is	X	n/a	n/a
236-Z	X	X	Fill ducting between 236-Z and 291-Z	X	X	n/a
241-Z	X	X	Fill >30.5 cm (12") diameter ducting. Remove trench piping between 242-Z, 234-5Z and 241-Z and fill trench	X	X	n/a
241-ZA	X	X	Bldg. slab stabilized as is	X	n/a	n/a
241-Z-RB (207-Z)	X	X	Bldg. slab stabilized as is	X	n/a	n/a
242-Z	X	X	Bldg. slab stabilized as is	X	X	n/a
243-Z	X	X	Bldg. slab stabilized as is	X	n/a	n/a
243-ZA	X	X	Bldg. slab stabilized as is	X	n/a	n/a
2736-Z	X	X	Bldg. slab stabilized as is	X	n/a	n/a
2736-ZA	X	X	Bldg. slab stabilized as is	X	n/a	n/a
2736-ZB	X	X	Bldg. slab stabilized as is	X	n/a	n/a
2904-ZA	X	X	Bldg. slab stabilized as is	X	n/a	n/a
2904-ZB	X	X	Bldg. slab stabilized as is	X	n/a	n/a
291-Z & 291-Z-001 Stack	X	X	Bldg. slab stabilized as is	X	X	n/a

Table 4-1. Alternatives Considered for PFP Sub-Grade[1]. (5 pages)

Structure/Installation	Alternative 1 – No Action	Alternative 2 – Surveillance and Maintenance	Alternative 3 – Stabilize and Leave in Place	Alternative 4 – RTD
Contaminated French Drains				
216-Z-13 French Drain (also miscellaneous stream number 261)	X	X	Due to 2.7 m (9-ft) of clean overburden, French Drain stabilized as is.	Removed if 291-Z is removed.
216-Z-14 French Drain (also miscellaneous stream number 262)	X	X	Due to 2.7 m (9-ft) of clean overburden, French Drain stabilized as is.	Removed if 291-Z is removed.
216-Z-15 French Drain (also miscellaneous stream number 263)	X	X	Due to 4.9 m (16 ft) of clean overburden, French Drain stabilized as is.	Removed if 291-Z is removed.
Contaminated Injections Wells				
Miscellaneous Stream Number 232	X	X	Remove top 30.5 cm (1') of gravel then cover.	X
Miscellaneous Stream Number 234	X	X	Remove top 30.5 cm (1') of gravel then cover.	X
Miscellaneous Stream Number 235	X	X	Remove top 30.5 cm (1') of gravel then cover.	X
Unplanned Releases				
Undocumented UPR @ 241-Z Trench	X	X	UPRs stabilized as is	X
Undocumented UPR @ beneath 234-5Z	X	X	UPRs stabilized as is	X
UPR-200-W-23	X	X	UPRs stabilized as is	X
UPR-200-W-103	X	X	UPRs stabilized as is	X
Contaminated Buried Pipelines & Diversion Boxes				
Diversion Box No. 1 (200-W-58)	X	X	Diversion box stabilized as is	X
Diversion Box No. 2 (200-W-59)	X	X	Diversion box stabilized as is	X
241-Z to 241-ZA				
½"-M9	X	X	n/a	X
½"-Supply & Return	X	X	n/a	X
2736-ZB to tie-in west of 241-Z				
3"-DR-M24	X	X	n/a	X
236-Z to 241-ZB				
1"-CUU-5030-M9	X	X	n/a	X
232-Z to 241-Z				
3"-D6	X	X	n/a	X
234-5Z to 241-Z				
2"-LSW/HSW-M9	X	X	n/a	X
2"-LSW/HSW-M9	X	X	n/a	X
3"-D8-1085	X	X	Remove piping in concrete trenches between 234-5Z, 241-Z, and 242-Z.	X
3"-D7-1084	X	X	Remove piping in concrete trenches between 234-5Z, 241-Z, and 242-Z.	X
8"-D6	X	X	Remove piping in concrete trenches between 234-5Z, 241-Z, and 242-Z.	X
4"-D4-1081	X	X	Remove piping in concrete trenches between 234-5Z, 241-Z, and 242-Z.	X

Table 4-1. Alternatives Considered for PFP Sub-Grade[1]. (5 pages)

Structure/Installation	Alternative 1 – No Action	Alternative 2 – Surveillance and Maintenance	Alternative 3 – Stabilize and Leave in Place	Alternative 4 – RTD
4"-D5-1082	X	X	Remove piping in concrete trenches between 234-5Z, 241-Z, and 242-Z.	X
241-Z/241-Z-RB to 241-Z-361				
4"& 6"-Process Waste Drain	X	X	n/a	X
6"-Waste Water	X	X	n/a	X
241-Z to Manhole-#Z7 (near 2904-ZA)				
6"-Waste Water	X	X	n/a	X
234-5Z to 241-Z-RB				
8"-D3	X	X	n/a	X
Pipelines between Diversion Box No. 1 and No. 2, from/to diversion boxes to/from 241-Z-361, adjacent drain fields, 216-Z-2, 216-Z-3 and 216-Z-12 Cribs				
6"-Process Waste	X	X	n/a	X
8"-Process Waste	X	X	n/a	X
6"&12"-Process Waste Drain	X	X	Fill 30.5 cm (12") segment	X
6"-Process Waste	X	X	n/a	X
4"&12"-Drain	X	X	Fill 30.5 cm (12") segment	X
8"-Process Waste Drain	X	X	n/a	X
4"&12"-Drain	X	X	Fill 30.5 cm (12") segment	X
8"-VCP	X	X	n/a	X
242-Z to 216-Z-1A				
1-½"&2"-M-21-1036	X	X	n/a	X
1-½"&2"-M-21-1035	X	X	n/a	X
Between 234-5Z and 242-Z				
1-½"-Hood 42	X	X	Remove piping in concrete trenches between 234-5Z, 241-Z, and 242-Z.	X
1-½"-M-21-1036	X	X	Remove piping in concrete trenches between 234-5Z, 241-Z, and 242-Z.	X
4"-P-M21-1081	X	X	Remove piping in concrete trenches between 234-5Z, 241-Z, and 242-Z.	X
4"-P-M21-1082	X	X	Remove piping in concrete trenches between 234-5Z, 241-Z, and 242-Z.	X
3"-P-M21-1084	X	X	Remove piping in concrete trenches between 234-5Z, 241-Z, and 242-Z.	X
3"-P-M21-1085	X	X	Remove piping in concrete trenches between 234-5Z, 241-Z, and 242-Z.	X
4"-M21-D6	X	X	Remove piping in concrete trenches between 234-5Z, 241-Z, and 242-Z.	X
241-Z to Tank Farms				
2"-HSW-202-M8	X	X	Plug pipeline as it exits PFP fenced area (approximately at N40561.6/W76350)	X
2"-HSW-203-M8	X	X	Plug pipeline as it exits PFP fenced area (approximately at N40561.6/W76350)	X
234-5Z to 216-Z-9				
1-½"-Drain	X	X	Plug at 216-Z-9 Crib fence	X
1-½"-Drain	X	X	Plug at 216-Z-9 Crib fence	X

Table 4-1. Alternatives Considered for PFP Sub-Grade[1]. (5 pages)

Structure/Installation	Alternative 1 – No Action	Alternative 2 – Surveillance and Maintenance	Alternative 3 – Stabilize and Leave in Place	Alternative 4 – RTD
234-5Z to 241-Z-8				
1-½"-Drain	X	X	Plug near inlet to 241-Z-8 Settling Tank	X
1-½"-Drain	X	X	Plug near inlet to 241-Z-8 Settling Tank	X
232-Z to 241-Z				
3"-D6-Drain[3]	X	X	n/a	X
242-Z to 241-Z				
1-½"-P-M21-1020-HNO3	X	X	n/a	X
1-½"-P-M21-1011-ANN	X	X	n/a	X
1-½"-P-M10-1014-NAOH	X	X	n/a	X
Manhole #Z1 (near 232-Z) to 216-Z-20				
15" VCP	X	X	Fill	X
Manhole #Z4 (west of 236-Z) through manholes #Z5 and #Z6 to manhole #Z7 (near 2904-ZA)				
15"-VCP Drain	X	X	Fill	X
15"-VCP Drain	X	X	Fill	X
15"-VCP Drain	X	X	Fill	X
236-Z to manhole #Z4 (west of 236-Z)				
3"-D3 Drain	X	X	n/a	X
6"-D1 Drain	X	X	n/a	X
4"-Condensate Drain	X	X	n/a	X
Manhole #Z5 (south of 243-ZA)/243-Z/243-ZB to 243-ZA sump and 243-ZA sump to manhole #Z6 (SW of 243-ZA)				
6"-Drain	X	X	n/a	X
10"-CS	X	X	n/a	X
4"-CS	X	X	n/a	X
3"-CS	X	X	n/a	X
Manhole #Z3 (west of 291-Z) to manhole #Z6 (SW of 243-ZA)				
15"-VCP Drain	X	X	Fill	X
291-Z to manhole #Z3 (west of 291-Z)				
6"-VCP Drain	X	X	n/a	X
234-5Z to manhole #Z3 (west of 291-Z)				
3"-Acid Proof Chemical Drain	X	X	n/a	X
234-5Z, cleanout point (north of 2736-ZB), 232-Z, and cleanout point (north of 232-Z) to manhole #Z1 (south of 232-Z)				
4"-VCP	X	X	n/a	X
15"-VCP	X	X	Fill	X
15"-VCP	X	X	Fill	X
15"-VCP	X	X	Fill	X
6"-VCP	X	X	n/a	X
6"-CS	X	X	n/a	X
6"-CS	X	X	n/a	X
2736-Z to cleanout point (north of 2736-ZB)				
4"-CI	X	X	n/a	X
234-5Z to cleanout point (north of 2736-ZB)				

Table 4-1. Alternatives Considered for PFP Sub-Grade[1]. (5 pages)

Structure/Installation	Alternative 1 – No Action	Alternative 2 – Surveillance and Maintenance	Alternative 3 – Stabilize and Leave in Place	Alternative 4 – RTD
15"-VCP	X	X	Fill	X
10"-VCP	X	X	n/a	X
12"-VCP	X	X	Fill	X
12"-VCP	X	X	Fill	X
12"-VCP	X	X	Fill	X
12" VCP	X	X	Fill	X

[1] Reference H-2-832896, Rev. 0.
[2] Alternative 4 Options A, B & C, will still require some level of institutional controls, site inspection and surveillance, existing cover maintenance (including weed /pest control), natural attenuation monitoring, reporting, site reviews, and monitoring.
[3] Pipeline may not exist.

n/a = not applicable
PFP = Plutonium Finishing Plant
RTD = remove, treat, and dispose
S&M = surveillance and maintenance
UPR = unplanned release
VCP = vitrified clay pipe

4.1 ALTERNATIVE ONE: NO ACTION

An analysis of a No-Action alternative is included to provide a baseline for other active alternatives. Under a No-Action alternative, no building slabs, wastes, or pipelines would be removed and there are no S&M activities specific to the sub-grade structures and installations. Existing institutional controls (e.g., signage, fencing) would not be maintained. This alternative delays any action regarding the sub-grade structures and installations until the final remedial action(s) for PFP, or the multiple OUs that address components of PFP, is/are implemented.

4.1.1 Cost Estimate for Alternative One: No Action

The No-Action alternative assumes no activities will be taken at any sites within PFP. As a result, there are no costs for this alternative.

4.2 ALTERNATIVE TWO: SURVEILLANCE AND MAINTENANCE

The Surveillance and Maintenance alternative involves regular inspection and maintenance of building slabs and contamination control covers to ensure their continued integrity and includes maintenance of the 291-Z roof, along with visual inspection and radiation surveys of the surface areas surrounding sub-grade structures and installations to detect any physical changes (e.g., structural collapse) or releases.

For purposes of costing the alternatives analysis, it is assumed that the S&M program will cover the entire area inside the outer security fence at PFP, which encompasses approximately 25 acres and the majority of the sub-grade items. This assumption does not preclude selection of one of the other two active alternatives (i.e., stabilize and leave in place, remove, treat, and dispose [RTD]) for individual sub-grade structures or installations on a case-by-case basis. The S&M cost will be only minimally impacted by the removal of individual sub-grade installations from the S&M program because of the relatively large area covered by this alternative.

4.2.1 Cost Estimate for Alternative Two: Surveillance and Maintenance

The cost estimate includes costs for activities such as site radiation surveys, vegetation/pest control and 291-Z roof maintenance, and others. Details of the estimate are presented in the cost backup report (HNF-30998, *Cost Estimate Documentation for the Engineering Evaluation/Cost Analysis for the Plutonium Finishing Plant Sub-Grade Structures and Installations*).

The primary annual/periodic costs for Alternative 2 are surveillance, cover maintenance, and monitored natural attenuation costs. They are shown in Table 4-2. This alternative also includes the cost of long-term groundwater monitoring. A one time capital cost associated with this alternative will be the replacement of the 291-Z roof. The assumed life expectancy of the roof is twenty years. Otherwise, Alternative 2 consists of these general activities: implementation of institutional controls, site inspection and surveillance, existing cover maintenance (including vegetation/pest control), natural attenuation monitoring, reporting, site reviews, and groundwater monitoring.

Table 4-2. Costs for Alternative Two: Surveillance and Maintenance.

Cost Type	Constant Dollars (Non-Discounted, $1,000)	Present Worth (Discounted, $1,000)
S&M	$7,747	$5,699
Capital	$0	$0
Total Cost	$7,747	$5,699

S&M = surveillance and maintenance

4.3 ALTERNATIVE THREE: STABILIZE AND LEAVE IN PLACE

Under this alternative, select contaminated sub-grade items are evaluated as to the appropriateness of their condition as provided by the PFP above-grade structures EE/CA or the 232-Z EE/CA. Other contaminated sub-grade items are selected for specific stabilization activities. S&M activities are effectively the same as for Alternative 2.

The designated end point for building slabs under the PFP above-grade structures EE/CA and 232-Z EE/CA requires that building slabs are covered with a fixative to stabilize any contamination. Piping and equipment in below-grade portions of structures are removed to the extent possible or meet low-level waste criteria. If after clean-out under the PFP above-grade removal action, it is not possible to achieve low-level waste criteria for 241-Z tanks and tank system remnants, contamination will be fixed in place and tanks/system remnants would remain for future action. Contamination control covers are placed where necessary. The 232-Z buried ductwork is filled with grout. The 241-Z-RB Retention Basin, its valve pit, the two diversion boxes and the 243-ZA tank pit are filled with a controlled-density fill material.

There are only two additional sub-grade structure activities undertaken by this alternative as appropriate for stabilization. The first is to fill the ductwork between 236-Z and 291-Z with a stabilizing fill material. The second is to fill the 241-Z concrete trench that travels between the 234-5Z Building and the 241-Z Building including the branch from 242-Z to 234-5Z. Prior to filling this trench, piping within is removed. No other stabilization activities need be pursued for the building slabs under this alternative.

Specific sub-grade installations are filled with a controlled-density fill material or another inert substance to prevent the migration of residual contamination and/or, in the case of large-diameter installations, reduce the potential for collapse of the installation over time, leading to subsidence of the earth cover. The 241-Z Vault area was calculated to remain stable without control density fill. In addition, there is concern that filling the vault could interfere with future remedial actions. This alternative also is used selectively to prevent the inadvertent introduction of liquids into a contaminated pipeline, or to avoid migration of contamination within a pipeline.

Injection wells (miscellaneous stream #232, 234, and 235) have the top 0.3 m (1 ft) of gravel removed, backfilled to fill the void, and are covered with a 3 m by 3 m (10 ft by 10 ft) concrete cap. French drains are located below 2.7 to 4.8 m (9 to 16 ft) of clean overburden so they are stabilized as is. Pipelines and ductwork with >30 cm (>12 in.) diameters are filled to prevent subsidence (includes filling of in-line man holes and cleanout boxes). To prevent accidental introduction of liquids, pipelines, regardless of diameter, are physically interrupted by plugging the pipeline where it leaves the PFP Complex.

Because the undocumented UPR under the 241-Z concrete trench and the potential UPRs under the 234-5Z Building slab, where pipelines re-enter the tunnels, are covered by the structures above them, no additional stabilization action is needed under this alternative. The same situation applies to UPR-200-W-23, which is covered by asphalt, and UPR-200-W-103, which has had an area measuring 7.6 m (25 ft) by 1.8 m (6 ft) by 2.1 m (7 ft) deep excavated around the leak.

4.3.1 Cost Estimate for Alternative Three: Stabilize and Leave In Place

The cost estimate includes costs for activities such as mobilization and demobilization, monitoring and sampling, site work, soil excavation, and others. Details of the estimate are presented in the cost backup report (HNF-30998).

The annual/periodic costs for Alterative 3 are the same as for Alternative 2. Capital costs are for stabilization activities that will be applied to a selected set of pipelines, ducts, injection wells, and manholes. Alternative 3 costs, using the same estimating methods as in Alternative 2, are shown in Table 4-3.

Table 4-3. Costs for Alternative Three: Stabilize and Leave in Place.

Cost Type	Constant Dollars (Non-Discounted, $1,000)	Present Worth (Discounted, $1,000)
S&M	$7,747	$5,699
Capital	$5,519	$5,519
Total Cost	$13,266	$11,218

S&M = surveillance and maintenance

4.4 ALTERNATIVE FOUR: REMOVE, TREAT, AND DISPOSE

Under this alternative, sub-grade structures and installations will be excavated, packaged, and disposed of at an appropriate waste facility. Removal of sub-grade items generally includes an additional 1 m (3 ft) of soil beneath the sub-grade item and 1 m (3 ft) beyond the sub-grade item's footprint (if a building slab) or centerline (if a pipeline) in order to capture nearby contaminated soil. S&M is reduced for this alternative as sub-grade items are removed (e.g., if the 291-Z below-grade structure is removed, there will no longer be any 291-Z roof maintenance or repairs). S&M will still be needed as not all sub-grade items will necessarily be removed and some level of contaminated soil will remain.

The end point under this alternative is driven by the target depth, which is based on reduction of an exposure hazard, not a defined cleanup standard. Sampling will be performed only to establish residual contamination levels at the completion of the action, not to verify "final" cleanup levels.

To give some consideration to the extent of contamination on building slabs, this alternative provides three removal options for the building slabs:

- Option (A) – All building slabs (including below-grade sections) are removed.
- Option (B) – Building slabs (including below-grade trenches, ductwork, 241-Z tanks and vaults, 291-Z fan houses and exhaust plenums) are removed for priority buildings, 236-Z, 241-Z, 242-Z, and 291-Z only. These structural slabs were selected for individual treatment based on the residual plutonium inventory expected to remain on these slabs.
- Option (C) - No building slabs are removed.

Removal of a building slab includes an additional 1 m (3 ft) of soil beneath the lowest portion of the building slab (e.g., the 241-Z below-grade vault floor) and laterally beyond the building slab footprint.

The only exception is the 234-5Z Building slab, as there are approximately 52 pipe trenches under this slab. These trenches are approximately 1 m (3 ft) wide and 1 m (3 ft) deep and vary in length; some are approximately 11 m (36 ft) long. Pipelines from various locations in the building penetrate the first floor slab and travel beneath the slab, either through these trenches or first through soil (direct buried) prior to entering the below-grade tunnels. Digging up 1 m (3 ft) of soil under the trenches is expected to address the majority of undocumented UPRs, if any exist, below the trenches. Because the trenches are recessed 1 m (3 ft) below the first floor slab, excavation of 1 m (3 ft) of soil beneath the trenches results in a net of 2 m (6 ft) beneath the first floor building slab. Because the trenches are in close proximity to one another, removal of the 234-5Z Building slab where most of the trenches are located will be performed to 2 m (6-ft) below the slab. The rest of the building slab will be removed with 1 m (3 ft) of soil. Removal of the 234-5Z Building slab would include the tunnels, which also will include an additional 1 m (3 ft) of soil beneath the tunnel floor.

The individual slabs selected for RTD in Option B are described below:

- **236-Z Building**. The status of the floor slab lying below the stainless steel pans covering the floor of room 12 in the 236-Z Building will be difficult to ascertain until the residues on the surface of the floor pans have been removed and the pans are gone. There are several kilograms of plutonium lying on the pans; this condition makes realistic analysis of quantities below the pans impractical. It is known that some of the pans have leaked in the past, and it is known that the organic liquid layer that was on the floor at the time leaks occurred was rather rich in plutonium content.

- **241-Z Facility**. This facility houses five waste tanks within individual concrete vaults. There is a history of process leaks occurring in the tank vaults and one tank failure, which contaminated the interior of the concrete vaults. In general, the 241-Z transition scope will remove process piping, seal exterior penetrations to the below grade structure, clean and fix the tank vault surfaces, clean and fix the interior of the waste tanks, remove the above grade structure, and install an environmental barrier over the existing tank vault cover. The barrier will prevent water intrusion into the below grade tank vaults in lieu of filling the void spaces which would complicate future actions. Although the transition work is in progress it is *estimated that after completion, there may still be approximately 200g (7 oz)of plutonium* fixed in the surfaces of the concrete structure, embedded piping, and waste tanks. There also is the potential for soil contamination from leaks in process and sample lines. The site evaluation to date indicates the potential for the tanks to contain sufficient plutonium contamination when removed to designate as transuranic waste, although when considered in the context of the overall sub-grade structure the vault contents likely qualify as low–level waste.

- **242-Z Building.** The concrete floors in the 242-Z Building control room and tank room have been estimated to be contaminated with up to a total of 20 grams (0.7 oz) of plutonium. Removal of a thin surface layer from these floors may be appropriate after the glove boxes and tanks are gone. There is no information that suggests significant transuranic contamination below the 242-Z floors.

- **291-Z Building.** This building is estimated to contain about 40 to 60 grams (1.4 to 2 oz) total of plutonium. These numbers are based on an estimate for a small sump in the mechanical room (40 grams [1.4 oz]), and a composite estimate of between 2 and 20 grams (0.07 and 0.7 oz) for the entire ventilation duct system downstream of the final high-efficiency particulate air filters in the 234-5 Z Building, including the stack manifold, the interior of the chimney, and the breeching duct. Complete removal of the sump could be accomplished with relatively modest effort. Following removal of the 61 m (200 ft) tall concrete chimney, leaving the plutonium undisturbed in the ventilation pathway structures, accompanied by appropriate backfilling would be consistent with the recent stabilization actions for the retention basins and the 232-Z Building slab and ducts.

Due to their proximity to the building and their depth, French drains are removed only if the 291-Z Building slab is also removed; therefore under Options A and B, French drains are also removed. However, under Option C, French drains are not removed as none of the building slabs are removed. Furthermore, under Options A and B, 1 m (3 ft) of soil would be removed from beneath the contaminated French drains as well.

In addition to whichever option is chosen for the building slab, each option includes these activities: 1 m (3 ft) of soil would be removed from beneath the injection wells (miscellaneous stream #232, 234, and 235) as well as under contaminated buried pipelines. Removal for pipelines includes a 1 m (3 ft) radius beneath and to both sides from the pipe centerline and 0.3 m (1 ft) above the pipe. If pipelines are in concrete trenches, concrete trenches are removed too.

Removal of the top 1 m (3 ft) of the undocumented UPR site under the 241-Z concrete trench and the potential UPR sites under the 234-5Z Building slab will occur with the removal of the pipe trench or structure over them. The UPR under the 241-Z concrete trench will be removed when the pipe trench is removed. Under Option C (no building slabs removed), and Option B (only 236-Z, 241-Z, 242-Z and 291-Z are removed) the potential undocumented UPRs under 234-5Z will remain. For UPR-200-W-23, a 28 m_2 by 1 m (300 ft_2 by 3 ft) deep area is removed. As 2.1 m (7 ft) of soil has already been removed from the top of UPR-200-W-103, no further removal of soil is performed at this site.

4.4.1 Cost Estimate for Alternative Four: Remove, Treat, and Dispose

Like Alternative 3, estimates include costs for activities such as mobilization and demobilization, monitoring and sampling, site work, soil excavation, and others. Details of the estimate are presented in the cost backup report (HNF-30998).

Annual/periodic and institutional control costs are included in Alternative 4 because not all contaminants will be removed. These costs are the same as for Alternative 2, except that roof maintenance and repair for 291-Z is not required for Options A and B in which this sub-grade building is removed.

Pipelines, underground structures and building slabs requiring removal are excavated to the required depth and contaminated material is removed to ERDF for disposal. The sites are then backfilled and remediated. Alternative 4 costs, using the same estimating methods as in Alternative 2, are shown in Table 4-4.

Table 4-4. Costs for Alternative Four: Remove, Treat and Dispose.

Cost Type	Constant Dollars (Non-Discounted, $1,000)	Present Worth (Discounted, $1,000)
Alternative 4, Option A (All Slabs Removed)		
S&M	$7,503	$5,539
Capital	$54,874	$54,874
Total Cost	$62,377	$60,413
Option B (Priority Slabs Removed)		
S&M	$7,503	$5,539
Capital	$39,144	$39,144
Total Cost	$46,647	$44,683
Option C (No Slabs Removed)		
S&M	$7,747	$5,699
Capital	$30,527	$30,527
Total Cost	$38,274	$36,226

S&M = surveillance and maintenance

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5.0 ANALYSIS OF ALTERNATIVES

This analysis assesses each of the alternatives identified in Chapter 4.0 against three primary criteria: effectiveness, implementability, and cost. To provide a more comprehensive analysis, the criterion of effectiveness is further divided into several subcategories. Therefore, each alternative will be evaluated against the following factors:

- Effectiveness
  - Protectiveness
    - Overall protection of human health and the environment
    - Protection of workers during implementation
    - Protection of the environment
  - Compliance with applicable federal and state laws and regulations (e.g., ARARs)
  - Long-term effectiveness and permanence
  - Ability to achieve RAOs
    - Reduction of toxicity, mobility, or volume through treatment
    - Short-term effectiveness

- Implementability
  - Technical feasibility
    - Construction and operational considerations
    - Demonstrated performance/useful life
    - Adaptable to environmental conditions
    - Contributes to remedial performance
    - Can be implemented quickly
  - Availability of equipment, personnel, services, and disposal
    - Equipment
    - Personnel and services
    - Treatment and disposal services

- Cost.

Each criterion is briefly explained in the following sections along with an analysis of each alternative relative to each criterion. Finally, the alternatives are compared against one another relative to each criterion.

The alternatives are reiterated below:

- Alternative One: No Action
- Alternative Two: Surveillance & Maintenance
- Alternative Three: Stabilize and Leave in Place
- Alternative Four: Remove, Treat, and Dispose.

5.1 EFFECTIVENESS

The effectiveness of an alternative can be evaluated in terms of the ability of the option to achieve RAOs. The following sections review the various aspects of this criterion.

5.1.1 Protectiveness

The overall protection of human health and the environment is the primary objective of the selected alternative. This criterion addresses whether the proposed action achieves adequate overall elimination, reduction, or control of risks to human health and the environment posed by the likely exposure pathways. This criterion must be met for an alternative to be eligible for consideration. Evaluation of the alternatives against this criterion was based on a qualitative analysis based on the estimated inventory of hazards in the facilities to be addressed.

Alternative 1 (No Action) has no components that would monitor, eliminate, reduce, or control risks to human health and the environment. As building slabs deteriorate due to exposure to the weather, contamination on or in the building slabs will be released to the environment. This result is mitigated, however, by the placement of contamination control covers on building slabs under the PFP above-grade structures Action Memorandum (DOE/RL-2005-13, *Action Memorandum for the Plutonium Finishing Plant Above-Grade Structures Non-Time Critical Removal Action*) and PFP complex end point criteria (HNF-22401). However, under this alternative no maintenance of contamination control covers is provided and this mitigating factor will eventually disappear. As pipelines degrade over time, there is the potential for residual contamination to be released and become accessible to transport in the vadose zone, or to dispersion in the atmosphere, resulting in worker exposure. Soil contamination at UPRs also could potentially migrate, ultimately impacting groundwater or resulting in worker exposure. While there is no basis to believe a significant contaminant inventory remains in the pipelines or injection wells and the minimal amount of annual precipitation lessens some of these concerns, the lack of maintenance of the contamination control covers increases other concerns. The no-action alternative does not include an ongoing S&M program that would monitor site conditions or limit site access. Therefore, Alternative 1 would not provide overall protection of human health and the environment and would not achieve the RAOs. Because this alternative would not meet the threshold criterion of protectiveness, it cannot be considered a viable alternative. On this basis, the no-action alternative was not carried through for further analysis.

Alternative 2 (Surveillance and Maintenance) includes maintenance of contamination control covers and visual and survey observations of the sub-grade structures and installations to detect any changes in site conditions. This alternative restricts building slab deterioration and the release of contamination on or in the building slabs to the environment through maintenance of the contamination control covers. Although this alternative does include groundwater monitoring, as noted above, site history indicates migration has only limited potential for occurring during the S&M period due to the minimal amount of annual precipitation and the lack of a significant contaminant inventory. Any deterioration of pipelines or injection wells might be inferred by observable changes in the surface (e.g., slumping). Under this alternative, existing clean backfill material over UPRs would be maintained. The Surveillance and Maintenance alternative ensures ongoing maintenance of contamination control covers on building slabs and back fill material over UPRs, includes groundwater monitoring, and allows for early detection of structural failure for larger diameter piping or sub-grade structures should surface indicators appear. Radiation surveys would provide data to ensure that site personnel are not exposed to unanticipated releases from sub-grade structures or installations. Alternative 2 (Surveillance and Maintenance) provides adequate protection of human health and the environment for stable structures and installations until a final action is taken.

Alternative 3 (Stabilize and Leave in Place) provides substantial near-term protection by actively preventing migration of contamination on building slabs, residues in pipelines, or soil contamination from UPRs or in injection wells, as opposed to the passive approach in Alternative 2. Stabilization minimizes the potential for a release to the environment or to site workers by use of a fill material or other methods to encapsulate or otherwise immobilize contamination, or to prevent the collapse of a pipeline or other installation. Protection would continue through the S&M period up to the implementation of the final remedial action for the PFP site. This alternative is the de facto condition for the building slabs, which will have an appropriate contamination control cover after demolition of the above-grade building structures. This alternative is appropriate for select underground structures or installations that contain a potentially significant inventory of contaminants (e.g., where radionuclide contamination in a pipeline could present a hazard to site personnel if it were to collapse). Stabilization could help to limit the potential for structural failure and ensure that contaminants do not migrate. Stabilization is considered for the pipe trench between the 242-Z and 234-5Z Buildings and 241-Z Building in order to further limit the potential for migration of contaminants from the pipeline leak at that site.

Alternative 4 (Remove, Treat, and Dispose) would accomplish the removal, treatment, as needed, and disposal of contaminated materials at ERDF, or its package and storage for disposal as transuranic waste. This reduces or eliminates the potential for a contaminant release. Building slabs and near-surface contaminated soils beneath the slabs would be removed entirely under Option A and selectively under Option B. Contaminated pipelines and surrounding soils associated with the pipelines would be removed and disposed at ERDF. This would reduce the potential for a release of contaminants. Protection would continue through an ongoing S&M program up to the implementation of the final remedial action for the PFP site. Alternative 4 would be the most effective means to protect human health and the environment in the long term.

During implementation of the activities associated with Alternatives 2, 3, or 4, there would be a potential for worker exposure and the potential for release of contaminants, with the largest potential for exposure associated with Alternative 4. The use of proven control technologies and strict adherence to safety and environmental regulations during these activities would minimize these risks. Alternative 4, by removing the sources of potential exposure, provides the highest level of overall protection.

Based on this analysis, Alternative 1 would fail to provide overall protection, whereas Alternatives 2, 3 and 4 each provide overall protection of human health and the environment, and are considered viable alternatives.

5.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

This criterion addresses whether an alternative will, to the extent practicable, meet ARARs and other federal and state statutes. Alternatives considered, to the extent practicable, should contribute to the efficient performance of any long-term action with respect to the release or threatened release. For the purposes of this analysis, onsite actions are deemed exempted from obtaining federal, state, and local permits. Non-promulgated standards also are to be considered, such as proposed regulations and regulatory guidance, to the extent necessary for the action to be adequately protective. Table 5-1 identifies the potential ARARs and "to-be-considered" standards for this analysis.

Key action specific ARARs for the alternatives being considered include waste management standards and standards controlling releases to the environment. The alternatives may include subsurface activities for some of the structures or installations within the scope of this analysis. Any subsurface activities would be conducted consistent with the ARARs, as appropriate, identified for that action.

The following sections provide a preliminary discussion of how the alternatives comply with ARARs. Where pertinent to the discussion of compliance, "to be considered" materials also are included.

5.1.2.1 Waste Management Standards

RCRA Subtitle C, implemented via 40 CFR 260 through 268, "Hazardous Waste Management System", governs the identification, treatment, storage, transportation, and disposal of hazardous waste. Authority for much of Subtitle C has been delegated to the state of Washington. Implementing state regulations contained in WAC 173-303 are applicable to any dangerous wastes generated during an action to reduce risk associated with the PFP sub-grade structures and installations. The regulations require identifying and appropriately managing dangerous wastes and dangerous waste components of mixed wastes, as well as identifying standards for treatment and disposal of these wastes. The land disposal restrictions established under RCRA (40 CFR 268) prohibit disposal of restricted wastes unless specific concentration- or technology-based treatment standards have been met. The land disposal restrictions are applicable to the treatment and disposal of dangerous or mixed wastes that may be generated during an action for land disposal onsite (e.g., at ERDF).

Dangerous and mixed wastes would likely be generated under Alternative 4, and to a lesser extent through the stabilization alternative (Alternative 3). The constituents of concern are primarily radioactive wastes; however, some mixed wastes also may be generated. Dangerous and/or mixed wastes are designated and managed in accordance with the dangerous waste management standards in WAC 173-303. Any wastes determined to be destined for onsite disposal would be treated, as appropriate, to meet the treatment standards of 40 CFR 268.

Radioactive low-level waste would be generated under Alternative 4, and to a lesser extent under the Alternative 3. Radioactive wastes are governed under the authority of the *Atomic Energy Act of 1954*. U.S. Nuclear Regulatory Commission performance objectives for land disposal of low-level radioactive waste are provided in "Licensing Requirements for Land Disposal of Radioactive Waste" (10 CFR 61, Subpart C). Although not applicable to DOE facilities, these standards are relevant and appropriate for any disposal facility that accepts low-level waste generated by the alternatives assessed by this analysis for onsite disposal. Waste generated would be disposed at ERDF, which is authorized to receive low-level waste resulting from remediation activities which meets the ERDF waste acceptance criteria. The ERDF waste acceptance criteria define radiological, chemical, and physical characteristics for waste proposed for disposal placement and compaction requirements. Waste that could not meet or be treated to meet the ERDF waste acceptance criteria are stored or disposed at an alternate EPA-approved facility. Any waste disposal occurring off of the Hanford Site requires an offsite determination by EPA pursuant to 40 CFR 300.440 and, for dangerous or mixed waste, compliance with administrative provisions of WAC 173-303.

EPA requirements for disposal of transuranic waste are specified under the "Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level, and Transuranic Radioactive Waste" (40 CFR 191). This regulation generally prohibits near-surface disposal of transuranic waste and establishes disposal methods and requirements that include the expectation that containment will be provided for 10,000 years. Transuranic waste may be generated under Alternative 4. The waste is transferred to the Central Waste Complex for interim storage pending offsite disposal at a geologic repository such as the Waste Isolation Pilot Plant.

Alternative 2 could require the generation of some limited amounts of waste as part of S&M; Alternative 3 also could result in generation of small quantities of waste in the course of stabilizing sites. Alternative 4 is the alternative that would generate the most significant volume of waste and for which the waste disposal ARARs would have the greatest impact. Each of these alternatives would require a waste management plan to be developed at the start of the implementation period, which would identify the specific applicable requirements. These requirements would be most extensive for Alternative 4, the RTD alternative. These requirements apply equally to the various sub-grade structures and installations.

5.1.2.2 Standards Controlling Releases to the Environment

Revised Code of Washington 70.94, "Washington Clean Air Act," requires regulation of radioactive air pollutants. The state implementing regulation WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides," sets standards which are as stringent or more so than the federal standards under the federal *Clean Air Act of 1990* and amendments, and under the federal implementing regulation, 40 CFR 61, "National Emissions Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities." The state standards protect the public by conservatively establishing exposure standards applicable to the maximally exposed public individual, be that individual real or hypothetical. To that end, the standards address any member of the public, at the point of maximum annual air concentration in an unrestricted area where any member of the public may be. Radionuclide airborne emissions from the facility are not to exceed amounts that would cause an exposure to any member of the public of greater than 10 mrem/yr effective dose equivalent. The state implementing regulation WAC 246-247, "Radiation Protection – Air Emissions," which adopts the WAC 173-480 standards and the 40 CFR 61, Subpart H standard, requires verification of compliance with the 10 mrem/yr standard, and would be applicable to any alternative generating airborne emissions.

WAC 246-247 further addresses emission sources emitting radioactive airborne emissions by requiring monitoring of such sources. This monitoring requires physical measurement of the effluent or ambient air. The substantive provisions of WAC 246-247 which require monitoring of radioactive airborne emissions are applicable to the alternatives.

The above state implementing regulations further address control of radioactive airborne emissions where economically and technologically feasible (WAC 246-247-040(3) and -040(4), "Radiation Protection - Air Emissions," "General Standards," and associated definitions). To address the substantive aspects of these requirements, best or reasonably achieved control technology will be addressed by ensuring that applicable emission control technologies (those successfully operated in similar applications) be used when economically and technologically feasible (i.e., based on cost/benefit). If it is determined that there are substantive aspects of the requirement for control of radioactive airborne emissions, then controls will be administered as appropriate using reasonable and effective methods.

The radionuclide emission standards apply to any fugitive, diffuse, and point-source air emissions of radionuclides generated during S&M and D&D activities associated with Alternatives 2, 3, or 4. If there is a potential for a nonzero radioactive emission, best available radionuclide control technology or as low as reasonably achievable control technology would be required. Only minimal air emissions are anticipated under Alternative 2, the Surveillance and Maintenance alternative; because these would be associated with maintenance concerns, it is not likely that any emissions would approach regulatory limits. Alternatives 3 and 4 would primarily use decontamination/stabilization of surfaces to control radiological contaminants and standard construction techniques to provide dust control during demolition. An air monitoring plan is prepared to minimize the associated releases. No liquid discharges are anticipated under Alternatives 2, 3, or 4; any liquids generated as part of pipeline stabilization or the RTD alternative would be captured and managed for appropriate disposal.

The federal implementing regulations contain requirements for managing asbestos material associated with demolition and waste disposal (40 CFR 61, Subpart M).

5.1.2.3 Cultural and Ecological Resource Protection Standards

The proposed alternatives would occur in previously disturbed areas; therefore, the likelihood of encountering cultural resources is considered low.

The *National Historic Preservation Act of 1966,* implemented via "Protection of Historic Properties" (36 CFR 800), requires federal agencies to evaluate and mitigate adverse effects of federal activities on any site eligible for inclusion on the National Register of Historic Places. As noted in Chapter 2.0, steps have been implemented to record the historic properties within PFP independent of this analysis. All of the alternatives meet this requirement equally.

5.1.2.4 Radiation Protection Standards

10 CFR 835, "Occupational Radiation Protection," establishes radiation protection standards, limits, and program requirements for protecting workers and visitors from ionizing radiation resulting from the conduct of DOE activities. It also requires that measures be taken to maintain radiation exposure as low as reasonably achievable. Although this regulation does not contain environmental standards and hence technically is not an ARAR, this requirement is applicable to activities at PFP.

A combination of personal protective equipment, personnel training, physical design features, and administrative controls will be used to ensure that the requirements for worker and visitor protection are met by Alternatives 2, 3, and 4. Individual monitoring will be performed as necessary to verify compliance with the requirements.

Radiation protection requirements apply to S&M activities under Alternative 2, as well as to the activities associated with stabilization (Alternative 3). Alternative 4 will be most affected by these requirements due to the extensive nature of the required intrusive work to complete this alternative.

5.1.2.5 Worker Protection

Worker protection standards are described in Occupational Safety and Health Administration regulations, national consensus standards, and DOE orders. The "Occupational Safety and Health Standards " (29 CFR 1910) establish exposure limits, personnel protection requirements, and decontamination methods for hazardous chemicals, as well as identification and mitigation of physical hazards associated with confined spaces, falling hazards, fire, and electrical shock. 29 CFR 1910 provides requirements for worker safety during construction activities. These requirements are applicable during S&M, stabilization, and removal and disposal activities. DOE orders and Occupational Safety and Health Administration protection standards technically are not considered ARARs, but are independently applicable. This standard will be most significant for activities conducted to implement Alternatives 3 and 4, particularly for those installations that require excavation and shoring.

Table 5-1. Identification of Potential Applicable or Relevant and Appropriate Requirements and 'To Be Considered' for the PFP Sub-Grade. (4 sheets)

Potential ARAR Citation	Potential ARAR or TBC	Requirement	Rationale for Use
WASTE MANAGEMENT STANDARDS			
Regulations pursuant to the *Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. – Implemented through the Hazardous Waste Management Act*, RCW 70.105			
Dangerous Waste Regulations, (WAC 173-303):			
Solid Waste Identification Specific subsections: WAC 173-303-016 WAC 173-303-017	ARAR	These regulations define how to identify when materials are and are not solid waste.	These regulations are applicable because they define how to determine which materials are subject to the designation regulations.
Dangerous/Mixed Waste Designation Specific subsections: WAC 173-303-070 WAC 173-303-071 WAC 173-303-080 WAC 713-303-081 WAC 173-303-082 WAC 173-303-083 WAC 173-303-090 WAC 173-303-100 WAC 173-303-110	ARAR	These regulations define the procedures to be used to determine if solid waste requires management as dangerous waste. These regulations identify which waste codes are appropriate for application to the waste.	These regulations are applicable to the solid waste that will be generated.
Dangerous/Mixed Waste Management Specific subsections: WAC 173-303-073 WAC 173-303-077 WAC 173-303-170(3)	ARAR	These regulations establish the management standards for solid waste designated as dangerous or mixed waste. Special waste is addressed in WAC 173-303-073. Universal waste is addressed in WAC 173-303-077. Generator standards are identified through WAC 173-303-170(3).	These regulations are applicable to the management of materials subject to WAC 173-303. Specifically, the substantive standards for management of special waste and universal waste and the standards for management of dangerous/mixed waste are applicable to the interim management of certain waste that will be generated. WAC 173-303-170(3) includes the provisions of WAC 173-303-200 by reference. WAC 173-303-200 further includes certain standards from WAC 173-303-630 and -640 by reference.

Table 5-1. Identification of Potential Applicable or Relevant and Appropriate Requirements and 'To Be Considered' for the PFP Sub-Grade. (4 sheets)

Potential ARAR Citation	Potential ARAR or TBC	Requirement	Rationale for Use
Dangerous/Mixed Waste Disposal Specific subsection: WAC 173-303-140	ARAR	This regulation establishes state standards for land disposal of dangerous waste and incorporates by reference, federal land disposal restrictions of 40 CFR 268, that are applicable to solid waste that designates as dangerous or mixed waste in accordance with WAC 173-303-070.	This regulation is applicable to dangerous/mixed waste generated and removed from PFP for onsite land disposal.
"Polychorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," 40 CFR 761			
"Applicability," Specific Subsections: 40 CFR 761.50(b)(1) 40 CFR 761.50(b)(2) 40 CFR 761.50(b)(3) 40 CFR 761.50(b)(4) 40 CFR 761.50(b)(7) 40 CFR 761.50(c)	ARAR	These regulations establish standards for the storage and disposal of PCB waste.	The substantive requirements of these regulations are applicable to the storage and disposal of PCB liquids, items, remediation waste, and bulk product waste at ≥ 50 ppm. The specific subsections identified from 40 CFR 761.50(b) reference the specific sections for the management of PCB waste type. The disposal requirements for radioactive PCB waste are addressed in 40 CFR 761.50(b)(7).
Regulations pursuant to the *Atomic Energy Act of 1954*, 42 USC 2011, et seq			
Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste (40 CFR 191)			
TRU Waste Storage Standards Specific subsection: 40 CFR 191.3	ARAR	This regulation establishes the standard for management of spent nuclear fuel, high level, or TRU waste at any facility operated by the Nuclear Regulatory Commission or by Agreement States and for management at disposal facilities operated by the DOE.	This regulation potentially is relevant and appropriate to TRU waste during onsite storage.
Regulations pursuant to the *Solid Waste Management, Recovery and Recycling Act*, RCW 70.95			
"*Minimum Functional Standards for Solid Waste Handling*," (WAC 173-304)			
Nondangerous, Nonradioactive Solid Waste Management Specific subsections: WAC 173-304-190 WAC 173-304-200 WAC 173-304-350	ARAR	These regulations establish requirements for the management of solid waste that is not dangerous or radioactive waste. Affected solid waste includes garbage, industrial waste, construction waste, and ashes. Requirements for containerized storage, collection, transportation, treatment, and disposal of solid waste are included.	These regulations are applicable to onsite management and disposal of nondangerous, nonradioactive solid waste that could be generated.
To-Be-Considered pursuant to relevant facility acceptance criteria			
Environmental Restoration Disposal Facility Waste Acceptance Criteria (BHI-00139)	TBC	This document establishes waste acceptance criteria for ERDF.	Waste destined for management at ERDF must meet acceptance criteria to ensure proper disposal.
STANDARDS CONTROLLING RELEASES TO THE ENVIRONMENT			
Regulations pursuant to the *Clean Air Act of 1977*, 42 USC 7401, et seq.			
"*National Emission Standards for Hazardous Air Pollutants (NESHAP)*," (40 CFR 61)			

Table 5-1. Identification of Potential Applicable or Relevant and Appropriate Requirements and 'To Be Considered' for the PFP Sub-Grade. (4 sheets)

Potential ARAR Citation	Potential ARAR or TBC	Requirement	Rationale for Use
"Standard for Demolition and Renovation" 40 CFR 61.145(a)(1) 40 CFR 61.145(a)(5) 40 CFR 61.145(c) 40 CFR 61.150(a) 40 CFR 61.150(b) 40 CFR 61.150(c)	ARAR	These regulations define regulated asbestos-containing materials and establish removal requirements based on quantity present and handling requirements. These regulations also specify handling and disposal requirements for regulated sources having the potential to emit asbestos.	Although asbestos-containing materials are not anticipated, the substantive requirements of this standard are applicable, should asbestos-containing material be located during removal activities of associated pipelines and buried asbestos.
Regulations pursuant to the *Washington Clean Air Act*, RCW 70.94 / Department of Ecology, RCW 43.21A			
"*Radiation Protection - Air Emissions*," (WAC 246-247)			
WAC 246-247-035(1)(a)(ii)	ARAR	This regulation establishes requirements of 40 CFR 61, Subpart H, by reference. Radionuclide airborne emissions from the facility shall be controlled so as not to exceed amounts that would cause an exposure to any member of the public of greater than 10 mrem/yr effective dose equivalent.	Substantive requirements of this standard are applicable because actions may include activities such as open-air demolition of contaminated structures, excavation of contaminated soils, and operation of exhausters and vacuums, each of which may provide airborne emissions of radioactive particulates to unrestricted areas. As a result, requirements limiting emissions apply. This is a risk-based standard for the purposes of protecting human health and the environment.
"General Standards," WAC 246-247-040(1)	ARAR	Requires that emissions of radionuclides to the ambient air from DOE facilities shall not exceed amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr.	Substantive requirements of this standard are applicable, because actions may include activities such as decontamination and stabilization of contaminated structures, treatment of sludge, and operation of exhausters and vacuums, each of which may provide airborne emissions of radioactive particulates to unrestricted areas. As a result, requirements limiting emissions apply. This is a risk-based standard for the purposes of protecting human health and the environment.
"General Standards," "BARCT," WAC 246-247-040(3) "ALARACT," WAC 246-247-040(4)	ARAR	Emissions shall be controlled on an ALARA basis, at a minimum, to ensure that emission standards are not exceeded.	Substantive requirements of this standard are applicable, because fugitive, diffuse, and point-source emissions of radionuclides to the ambient air may result from activities performed, such as open-air demolition of contaminated structures, excavation of contaminated soils, and operation of exhauster and vacuums. This standard exists to ensure enhanced compliance with emission standards.
"Monitoring, Testing, and Quality Assurance," WAC 246-247-075(1), (2) WAC 246-247-075(8)	ARAR	Establishes the monitoring, testing, and quality assurance requirements for radioactive air emissions. Facility (site) emissions resulting from non-point and fugitive sources of airborne radioactive material shall be measured. Measurement techniques may include ambient air measurements, or in-line radiation detector or	Substantive requirements of this standard are applicable, because fugitive and non-point source emissions of radionuclides to the ambient air may result from activities performed, such as open-air demolition of contaminated structures and excavation of contaminated soils. This standard exists to ensure compliance with emission standards.

Table 5-1. Identification of Potential Applicable or Relevant and Appropriate Requirements and 'To Be Considered' for the PFP Sub-Grade. (4 sheets)

Potential ARAR Citation	Potential ARAR or TBC	Requirement	Rationale for Use
		withdrawal of representative samples from the effluent stream, as determined by the lead agency.	
"General Regulations for Air Pollution," (WAC 173-400)			
Air Contaminant Emission Standards Specific subsections: WAC 173-400-040 WAC 173-400-113	ARAR	These regulations require that reasonable precautions be taken to prevent the release of air contaminants associated with fugitive emissions resulting from materials handling, construction, demolition, or other operations. Emission standards are identified for visible, particulate, fugitive, odors, and hazardous air emissions. Emissions are to be minimized through application of best available control technology.	Requirements of this standard are relevant and appropriate to actions performed at PFP that could result in the emission of hazardous air pollutants (e.g., fugitive dust). Substantive standards established for the control and prevention of air pollution under this regulation might be applicable
"Controls for New Sources of Air Pollution," (WAC 173-460)			
"Control Technology Requirements," WAC 173-460-030 WAC 173-460-060	ARAR	Requires that new sources of air emissions provide the emission estimates identified in this regulation.	Substantive requirements of these standards are applicable, because there is the potential for toxic air pollutants to become airborne as a result of decontamination, demolition, and excavation activities. As a result, standards established for the control of toxic air contaminants are relevant and appropriate.
"Ambient Impact Requirement," WAC 173-460-070	ARAR	Requires that when applying for a notice of construction, the owner/operator of a new toxic air pollutant source that is likely to increase toxic air pollutant emissions shall demonstrate that emissions from the source are sufficiently low to protect human health and safety from potential carcinogenic and/or other toxic effects.	The substantive requirements of this standard are applicable, should actions result in the treatment of the soil or debris that contains contaminants of concern identified in the regulation as a toxic air pollutant.
"Ambient Air Quality Standards and Emission Limits for Radionuclides," (WAC 173-480)			
"Standards," WAC 173-480-050	ARAR	Whenever another federal or state regulation or limitation in effect controls the emission of radionuclides to the ambient air, the more stringent control of emissions shall govern.	The substantive requirements of this standard are applicable in that the more stringent aspect of federal or state emission limitation is specified as governing.
"Compliance," WAC 173-480-070(2)	ARAR	Requires that radionuclide emissions compliance shall be determined by calculating the dose to members of the public at the point of maximum annual air concentration in an unrestricted area where any member of the public may be.	The substantive requirements of this standard are applicable to actions involving disturbance or ventilation of radioactively contaminated areas or structures, because airborne radionuclides may be emitted to unrestricted areas where any member of the public may be.

ALARA = as low as reasonably achievable
ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
DOE = U.S. Department of Energy
ERDF = Environmental Restoration Disposal Facility
PCB = polychlorinated biphenyl
PFP = Plutonium Finishing Plant
RCW = *Revised Code of Washington*
TBC = to-be-determined
TRU = transuranic
WAC = *Washington Administrative Code*

5.1.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence criterion addresses whether the alternative leaves an unacceptable risk after the action has been taken. It also refers to the ability of an action to maintain long-term reliable protection of human health and the environment after the RAOs have been met.

Under the Surveillance and Maintenance alternative (Alternative 2), risk would potentially increase over time due to the potential deterioration of building slabs and pipelines, as well as the chance for contamination to migrate within the soil. Because the contaminated building slabs will have received a contamination control cover, this risk is minimized for the life of the cover, which is designed for twenty years. Pipelines and other sub-grade installations will likely deteriorate over time until the final remedial action, potentially releasing some inventories of contaminants to soil.

Alternative 3 (Stabilized and Leave in Place) provides moderate long-term protection of human health and the environment and adequate controls for most of the sites until implementation of a final action, which is assumed to occur within 20 years. Because contamination is left in place with this alternative, the risk of exposure and release remains and potentially increases with time. Therefore, over the long-term, the effectiveness of this alternative to remain protective may actually diminish.

Under Alternative 4 (Remove, Treat and Dispose), select contaminated structures and installations are removed and disposed, thereby creating a more effective remedy, and the greatest degree of long-term effectiveness.

5.1.4 Ability to Achieve Objectives for Alternatives

The reduction of toxicity, mobility, or volume through treatment criterion refers to an analysis of the anticipated performance of the treatment technologies that may be employed. It assesses whether the alternative permanently and significantly reduces the hazard posed through application of a treatment technology. This could be accomplished by destroying the contaminants, reducing the quantity of contaminants, or irreversibly reducing the mobility of contaminants. Reduction of toxicity, mobility, and/or volume contributes to overall protectiveness.

Alternative 2 provides no reduction in toxicity, mobility, or volume. Although the toxicity may be reduced with time for some of the radioactive contaminants through decay, this is not true for long-lived radionuclides (such as plutonium).

Alternative 3 would reduce the mobility of contaminants through treatment, using the appropriate technology to fix or stabilize waste constituents within select piping, injection wells, the 241-Z pipe trench and ductwork between 236-Z and 291-Z. Alternative 3 would not be applicable to some narrow-diameter piping, and would not prevent future degradation of piping or structures to which it is applied.

Alternative 4 could generate waste that might require treatment as necessary to meet waste acceptance criteria at ERDF or other disposal facilities. However, the fraction of waste requiring treatment would likely be low, and would involve a specific treatment technology that would reduce toxicity and/or mobility as part of the removal action. Mobility also will be reduced by disposal in a facility such as ERDF.

5.1.5 Short-Term Effectiveness

The short-term effectiveness criterion refers to an analysis of the speed with which the remedy achieves protection and its effectiveness for a limited time. The criterion also refers to any potential adverse effects on human health and the environment during the implementation phases of the alternative.

Alternative 2 would pose some limited potential threat to the workers involved with S&M, but would provide short-term protection to human health and the environment because the area would remain closed to the public and S&M limits potential exposure scenarios through detection and response to maintenance issues. In addition, worker exposure is minimized in relation to the active alternatives (3 and 4). The potential for exposure becomes greater over time, however, as the structures and installations deteriorate and the need for increased surveillance and major repairs arises. Deterioration and short-term concerns are related primarily to pipelines and UPRs for this alternative.

There is a potential for worker exposure and releases to the environment by implementing either Alternative 3 or 4. During implementation of Alternative 3, workers might experience an increased level of exposure, as compared to Alternative 2; however, this would be limited and would achieve a significant reduction in the potential for a release that could affect human health or the environment. Alternative 3 would complete the RAOs in a relatively short period, compared with the other alternatives.

Alternative 4 might increase potential exposure to workers early in the implementation of this alternative, because the workers would be removing and handling contaminated materials as part of the action. The handling of contaminated materials also increases the potential for a release to the environment especially to the air. Strict adherence to appropriate environmental regulations ensures that the potential to release is minimized. Limiting workers' time in contaminated areas and providing the necessary protective clothing and equipment appropriate to the tasks mitigates the risk to workers.

Alternative 4 is considered more effective in achieving protectiveness in the short term than Alternative 3. The risk to workers and potential for releases, however, is greater with Alternative 4 early in the implementation of this alternative. Once the contaminated building slabs, ductwork, pipelines, and soils are removed and disposed, the potential for exposure or release is significantly reduced. Exposure and the potential for release increases over time in Alternative 3. Thus, over the period until a final action, Alternative 4 has a lower potential for worker exposure and releases to the environment. In addition, Alternative 4 has fewer uncertainties with respect to its ability to ultimately achieve protectiveness than Alternative 3. Alternative 4 requires a longer period of time to implement due to the need for engineering studies and waste management associated with this alternative.

5.2 IMPLEMENTABILITY

Implementability refers to the technical feasibility of an alternative, including the availability of materials and services needed to implement the selected remedy.

Each alternative under consideration is implementable for the structures and installations under consideration. Environmental restoration workers at the Hanford Site are experienced in performing S&M, stabilization, removal, and waste disposal operations. Techniques and lessons learned from other site projects can be applied to the PFP sub-grade structures and installations. Facility and processes for disposal of waste are readily available on the Hanford Site.

Implementation of S&M activities, following the PFP above-grade EE/CA actions, would be significantly reduced because the major facilities within PFP would be reduced to a slab-on-grade condition. Thus, Alternative 2 could be easily implemented, with an S&M plan addressing remaining structures on a defined schedule. S&M techniques are widely used throughout the Hanford Site, and no specialized materials or services are required, except when major repairs are needed on a contaminated sub-grade structure or installation. As time passes, the primary difficulty with implementation is the increasing deterioration of the remaining structures. This would possibly increase the potential for worker exposure or physical hazards, although these risks can be mitigated through appropriate health and safety precautions. The deterioration would also present increasing challenges in attempting to maintain the integrity of the remaining structures to prevent contaminant releases. S&M also is a concern for small-diameter buried pipelines, because observing deterioration of the pipeline is not practicable. The same concern is applicable to UPRs, both below building slabs and beneath the 241-Z pipe trench.

Alternative 3 also is implementable, although it requires more planning and specialized skills than Alternative 2 to stabilize select structures and installations. In the near term, Alternative 3 is easier to implement than Alternative 4, because it would not include the greater number and complexity of engineering and design phases that would be associated with the removal of pipelines, pipe trenches, injection wells, UPRs, French drains, ductwork, and building slabs. In the long-term, however, implementation of Alternative 3 requires more S&M activities than Alternative 4 and may present greater worker protection and engineering challenges. In contrast, the minimal long-term S&M activities required for Alternative 4 would be very feasible because the major sources of contamination would be gone.

5.3 COST

The cost criterion evaluates the estimated cost of the alternatives and includes capital, operation and maintenance, and monitoring costs. Table 5-2 presents a summary of the costs associated with the various alternatives. There is no cost assigned to the no-action Alternative. Alternative 2 (Surveillance and Maintenance) has a total estimated present worth cost of approximately $6 million, while Alternative 3 (Stabilize and Leave in Place) has a total estimated cost of approximately $11 million. The additional S&M cost associated with the 291-Z Facility is for maintaining the roof of that structure. The total estimated cost associated with the various RTD alternative options range from approximately $36 million for no building slab removal (pipelines and other sub-grade installations would be removed) to approximately $60 million to remove all sub-grade structures and installations.

Table 5-2. Summary of Alternative Costs.

Alternative		Total Cost	
		Constant Dollars (Non-Discounted, $1,000)	Present Worth (Discounted, $1,000)
Alternative 1 – No Action		$0	$0
Alternative 2 – Surveillance and Maintenance		$7,747	$5,699
Alternative 3 – Stabilize and Leave in Place		$13,266	$11,218
Alternative 4 – Remove, Treat and Dispose	Option A (All Slabs Removed)	$62,377	$60,413
	Option B (Priority Slabs Removed)	$46,647	$44,683
	Option C (No slabs Removed)	$38,274	$36,226

5.4 OTHER CONSIDERATIONS

Cumulative impacts may occur in both the short-term and long-term because of the interrelationships among other activities, such as remediation of waste sites and groundwater, and deactivation and operation of surrounding facilities occurring in the 200 Areas. Along with actions discussed in this analysis, these other activities contribute to meeting the goals of 200 Area remediation, including protection of the environment. For this analysis, short-term cumulative impacts were considered in terms of worker dose, air quality, and resource allocation. During implementation of the activities associated with Alternatives 2, 3, or 4, there would be a potential for worker exposure and the potential for release of contaminants, with the largest potential for exposure associated with Alternative 4. The use of proven control technologies and strict adherence to safety and environmental regulations during these activities minimizes these risks.

With appropriate work controls, airborne releases are expected to be minor under all of the alternatives discussed, so the contribution to cumulative impacts on local and regional air quality would be minimal. With respect to resource allocation, Alternatives 2 through 4 as well as other 200 Areas activities would require resources in terms of budget, materials, and disposal space. The contribution to cumulative impacts is less for Alternative 2, greater for Alternatives 3 and greatest for Alternative 4, which would require the greatest budget resources (with a larger workforce required and the greatest near term economic influx to the local economy). No substantial irreversible and irretrievable commitment of natural resources (e.g., petroleum products, land) is anticipated by the alternatives.

In the longer term, the overall cumulative effect of activities in the 200 Areas would be to enhance the protection of workers, the public, and the environment, which is consistent with the values expressed by the regulators, stakeholders, affected tribes, and the public. The alternatives in this analysis (with the exception of the No Action Alternative) contribute to this enhanced protection. Alternative 4, by removing the sources of potential exposure, creates the greatest and most long-term positive effect. None of the alternatives would be expected to adversely affect existing ecological or cultural resources or to have any socioeconomic impacts, including disproportionately high and adverse impacts to minority or low-income populations.

5.5 RANKING THE ALTERNATIVES

Ranking the alternatives has been conducted with a systematic scoring described in the sections that follow, and includes the use of expert judgment to assess these criteria relative to the characteristics of each alternative and with consideration given to the alternative's flexibility for future remedial actions.

Base Case Results

The results summary is presented in Table 5-3, which shows the scoring result relative to a total of 100 and the corresponding ranking.

Table 5-3. Summary of the Ranking.

Alternative	Scoring Result	Ranking
Alternative 1 - No Action	0	Last
Alternative 2 – Surveillance and Maintenance	31.2	First
Alternative 3 - Stabilize and Leave in Place	19.2	Second
Alternative 4 - RTD, Option A (All Slabs Removed)	14.9	Fifth
Alternative 4 - RTD, Option B (Priority Slabs Removed)	16.0	Fourth
Alternative 4 - RTD, Option C (No Slabs Removed)	18.7	Third
Sum	100.0	

RTD = remove, treat, and dispose

Cost Sensitivity Analysis

The relative costs of the alternatives in this analysis are a significant factor in the high ranking of the Surveillance and Maintenance alternative. Therefore, sensitivity analyses have been conducted to test assumptions and conservatisms to assess if results are grossly skewed towards the recommended alternative. For that purpose, the following three factors were evaluated:

- The cost of mobilization and demobilization has been included in each activity associated with Alternatives 3 and 4, Options A, B, and C, which results in a conservatively high estimate. This was tested by reducing these costs by 75% for Alternatives 3 and 4, Options A, B, and C.

- The estimate assumes that most S&M activities continue to apply to the stabilization and RTD alternatives, which perhaps increases their costs more than would actually be experienced. This was tested by reducing these costs to zero for Alternative 4, Options A, B, and C, reasoning that stabilization does not remove much contaminant source.

- The potential that: a) the overall estimate for stabilization and RTD may be conservatively very high, or b) use of inverse of costs for grading may create too low a score for stabilization or RTD was evaluated. Both of these cases were tested in one analysis by reducing the importance of the Cost criterion, relative to the other criteria, from 33% to 10%.

The sensitivity analysis results are summarized in Attachment 3. In all cases, the Surveillance and Maintenance alternative has the highest ranking, as it does in the base case. The reason for the unchanged conclusion is the cost for stabilization and RTD activities are considerably higher than the costs for S&M activities, and that the Effectiveness and Implementability criteria scorings remain unchanged.

5.5.1 Description of the Ranking Method

A structured value analysis has been used to assess the qualitative criteria of Effectiveness and Implementability together with the quantitative criterion of Cost. Structured value analyses similar to this one are applied in a wide variety of decision-making venues. The method compares alternatives using normalization and weighting of individual scoring of the various attributes and criteria for each alternative.

As applied here, a simple scoring method is first used to arrive at an overall score for each of the criteria of Effectiveness and Implementability, respectively shown in Tables 5-4 and 5-5 (in these tables, the three alternatives and three options, within Alternative 4, are arranged vertically and the scope categories [i.e., attributes] are horizontal within each alternative).

Description of Scoring for Effectiveness and Implementability

For these qualitative criteria, the scoring method is a semi-qualitative one that uses expert judgment of the characteristics of the alternatives as they relate to each criteria/sub-criteria. A simplified numerical value or a "na" indicator is assigned to each of scope categories of PFP sub-grade features, with the following guidance:

1	The alternative is very effective or readily implemented
0	The alternative is somewhat effective or nominally implemented
-1	The alternative is ineffective or difficult to implement
"na"	The condition does not exist or the criterion is not relevant for the alternative

Using expert judgment, one of these values was assigned to each of the scope groupings of the alternatives for each criterion row (see Tables 5-4 and 5-5). The scoring is set up such that a maximum Effectiveness (or Implementability) score for an alternative equals 1.0. This would be the case if all entries in a matrix have a value of positive one (+1). This is done as follows:

- In combining scores, cells that are "na" are ignored in the scoring process. That is, it is not treated the same as a zero, which does have meaning.

- Scores are averaged for each criterion. Averaging is done first by each row, then vertically for criteria with sub-elements, and then separately for the elements of Effectiveness and Implementability.
- The result of this process is shown as the "Score" for each alternative's matrix, in the upper left corner of Tables 5-4 and 5-5.
- Negative combined scores are set to zero; which applies to the "no-action" alternative.

Cost Scoring

The Cost criterion uses the cost estimates shown in Table 5-6. The cost inputs to the scoring method are the estimates of capital costs and S&M costs, which are summed for each alternative. The estimate details are provided in the cost backup report (HNF-30998).

The analysis uses present worth costs (i.e., not constant dollar) to conform to the guidance in EPA 540-R-00-002.

5.5.2 Combining the Individual Criteria Scores

To arrive at an overall ranking, the three criteria are combined in Table 5-7 to arrive at an overall relative figure-of-merit for each alternative, which are summarized in Table 5-3. The highest score is the preferred alternative. The sections of Table 5-7 are:

- Step 1: The uppermost section contains individual scores for the qualitative criteria and the sum of the present-worth estimated S&M and capital costs for the Cost criterion.
- Step 2: The middle section normalizes the values in Step 1 to a value of 100 across the alternatives for a ranking within each criterion row. The inverse of cost is used for normalization because a high cost should result in a low score.
- Step 3: In the lower section, equal importance (i.e., weight) of 33.3% is applied to the normalized scores from Step 2 for each criterion. This step creates an overall total score of 100 (i.e., the sum of the bottom row containing the overall scores) among the alternatives.

The result is the relative value among the alternatives in which the one with the highest score is the most favorable, in the highlighted bottom row of Table 5-7.

Table 5-4. Effectiveness Analysis for PFP Sub-Grade Analysis. (Page 1 of 3)

Alternative 1 (No Action) Score = 0.00 of maximum of 1.00	Slabs		Pipelines		UPRs		Other	
	Other Slabs	Priority Slabs	Other Pipelines	Pipelines to 241-Z	Beneath Slabs	Beneath Pipe Trench	Ductwork	Injection Wells
I. Effectiveness								
A. Protectiveness								
a. Overall protection of human health and the environment	0	1	-1	-1	-1	-1	-1	-1
b. Protective of workers during implementation	na	na	na	na	na	na	na	na
c. Protective of the environment	0	1	-1	-1	-1	-1	-1	-1
B. Compliance with ARARs	na	na	na	na	na	na	na	na
C. Long-term Effectiveness and Permanence	-1	-1	-1	-1	-1	-1	-1	-1
D. Ability to Achieve Removal Objectives								
a. Reduction of toxicity, mobility, or volume through treatment	0	0	-1	-1	-1	-1	-1	-1
b. Short-term effectiveness	0	0	0	0	0	0	0	0

Alternative 2 (S&M) Score = 0.19 of maximum of 1.00	Slabs		Pipelines		UPRs		Other	
	Other Slabs	Priority Slabs	Other Pipelines	Pipelines to 241-Z	Beneath Slabs	Beneath Pipe Trench	Ductwork	Injection Wells
I. Effectiveness								
A. Protectiveness								
a. Overall protection of human health and the environment	0	1	0	0	0	0	0	0
b. Protective of workers during implementation	1	1	1	1	1	1	1	1
c. Protective of the environment	0	0	0	0	0	0	0	0
B. Compliance with ARARs	0	0	0	0	0	0	0	0
C. Long-term Effectiveness and Permanence	0	1	0	0	0	0	1	0
D. Ability to Achieve Removal Objectives								
a. Reduction of toxicity, mobility, or volume through treatment	0	0	0	0	0	0	0	0
b. Short-term effectiveness	0	1	0	0	0	0	1	0

Table 5-4. Effectiveness Analysis for PFP Sub-Grade Analysis. (Page 2 of 3)

Alternative 3 (Stabilization) Score = 0.28 of maximum of 1.00	Slabs		Pipelines		UPRs		Other	
	Other Slabs	Priority Slabs	Other Pipelines	Pipelines to 241-Z	Beneath Slabs	Beneath Pipe Trench	Ductwork	Injection Wells
I. Effectiveness								
A. Protectiveness								
Overall protection of human health and the environment	0	1	0	1	0	1	1	1
Protective of workers during implementation	1	1	0	-1	0	0	0	0
Protective of the environment	0	0	0	1	0	1	1	1
B. Compliance with ARARs	0	0	0	0	0	0	0	0
C. Long-term Effectiveness and Permanence	0	1	0	0	0	0	0	0
D. Ability to Achieve Removal Objectives								
a. Reduction of toxicity, mobility, or volume through treatment	0	0	0	1	0	1	1	1
b. Short-term effectiveness	0	1	0	1	0	1	1	1

Alternative 4 (RTD)□Option A (All Slabs) Score = 0.89 of maximum of 1.00	Slabs		Pipelines		UPRs		Other	
	Other Slabs	Priority Slabs	Other Pipelines	Pipelines to 241-Z	Beneath Slabs	Beneath Pipe Trench	Ductwork	Injection Wells
I. Effectiveness								
A. Protectiveness								
a. Overall protection of human health and the environment	1	1	1	1	1	1	1	1
b. Protective of workers during implementation	0	-1	0	-1	0	0	-1	0
c. Protective of the environment	1	1	1	1	1	1	1	1
B. Compliance with ARARs	1	1	1	1	1	1	1	1
C. Long-term Effectiveness and Permanence	1	1	1	1	1	1	1	1
D. Ability to Achieve Removal Objectives								
a. Reduction of toxicity, mobility, or volume through treatment	1	1	1	1	1	1	1	1
b. Short-term effectiveness	1	1	1	1	1	1	1	1

Table 5-4. Effectiveness Analysis for PFP Sub-Grade Analysis. (Page 3 of 3)

Alternative 4 (RTD)□Option B (Priority Slabs) **Score = 0.68 of maximum of 1.00**	Slabs		Pipelines		UPRs		Other	
	Other Slabs	Priority Slabs	Other Pipelines	Pipelines to 241-Z	Beneath Slabs	Beneath Pipe Trench	Ductwork	Injection Wells
I. Effectiveness								
A. Protectiveness								
a. Overall protection of human health and the environment	0	1	1	1	0	1	1	1
b. Protective of workers during implementation	1	-1	0	-1	1	0	-1	0
c. Protective of the environment	0	1	1	1	0	1	1	1
B. Compliance with ARARs	0	1	1	1	0	1	1	1
C. Long-term Effectiveness and Permanence	0	1	1	1	0	1	1	1
D. Ability to Achieve Removal Objectives								
a. Reduction of toxicity, mobility, or volume through treatment	0	1	1	1	0	1	1	1
b. Short-term effectiveness	0	1	1	1	0	1	1	1

Alternative 4 (RTD)□Option C (No Slabs) **Score = 0.64 of maximum of 1.00**	Slabs		Pipelines		UPRs		Other	
	Other Slabs	Priority Slabs	Other Pipelines	Pipelines to 241-Z	Beneath Slabs	Beneath Pipe Trench	Ductwork	Injection Wells
I. Effectiveness								
A. Protectiveness								
a. Overall protection of human health and the environment	0	1	1	1	0	1	1	1
b. Protective of workers during implementation	1	1	0	-1	1	0	-1	0
c. Protective of the environment	0	0	1	1	0	1	1	1
B. Compliance with ARARs	0	0	1	1	0	1	1	1
C. Long-term Effectiveness and Permanence	0	1	1	1	0	1	1	1
D. Ability to Achieve Removal Objectives								
a. Reduction of toxicity, mobility, or volume through treatment	0	0	1	1	0	1	1	1
b. Short-term effectiveness	0	1	1	1	0	1	1	1

Table 5-5. Implementability Analysis for PFP Sub-Grade Analysis. (Page 1 of 3)

Alternative 1 (No Action) **Score = 0.00 of maximum of 1.00**	Slabs		Pipelines		UPRs		Other	
	Other Slabs	Priority Slabs	Other Pipelines	Pipelines to 241-Z	Beneath Slabs	Beneath Pipe Trench	Ductwork	Injection Wells
II. Implementability								
A. Technical Feasibility								
a. Construction and operational considerations	na	na	na	na	na	na	na	na
b. Demonstrated performance/useful life	na	na	na	na	na	na	na	na
c. Adaptable to environmental conditions	na	na	na	na	na	na	na	na
d. Contributes to remedial performance	na	na	na	na	na	na	na	na
e. Can be implemented quickly	na	na	na	na	na	na	na	na
B. Availability								
a. Equipment	na	na	na	na	na	na	na	na
b. Personnel and services	na	na	na	na	na	na	na	na
c. Treatment and disposal services	na	na	na	na	na	na	na	na

Alternative 2 (S&M) **Score = 0.55 of maximum of 1.00**	Slabs		Pipelines		UPRs		Other	
	Other Slabs	Priority Slabs	Other Pipelines	Pipelines to 241-Z	Beneath Slabs	Beneath Pipe Trench	Ductwork	Injection Wells
II. Implementability								
A. Technical Feasibility								
a. Construction and operational considerations	1	1	1	1	1	1	1	1
b. Demonstrated performance/useful life	1	1	0	0	0	0	1	0
c. Adaptable to environmental conditions	na	na	na	na	na	na	na	na
d. Contributes to remedial performance	0	0	0	0	0	0	0	0
e. Can be implemented quickly	1	1	1	1	1	1	1	1
B. Availability								
a. Equipment	na	na	na	na	na	na	na	na
b. Personnel and services	1	1	1	1	1	1	1	1
c. Treatment and disposal services	0	0	0	0	0	0	0	0

Table 5-5. Implementability Analysis for PFP Sub-Grade Analysis. (Page 2 of 3)

Alternative 3 (Stabilization) Score = 0.33 of maximum of 1.00	Slabs		Pipelines		UPRs		Other	
	Other Slabs	Priority Slabs	Other Pipelines	Pipelines to 241-Z	Beneath Slabs	Beneath Pipe Trench	Ductwork	Injection Wells
II. Implementability								
A. Technical Feasibility								
a. Construction and operational considerations	1	1	na	0	na	0	0	0
b. Demonstrated performance/useful life	1	1	na	1	na	1	1	1
c. Adaptable to environmental conditions	na	na	na	na	na	na	na	na
d. Contributes to remedial performance	0	0	na	1	na	1	1	1
e. Can be implemented quickly	1	1	na	0	na	0	0	0
B. Availability								
a. Equipment	na	na	0	0	0	0	0	0
b. Personnel and services	1	1	0	0	0	0	0	0
c. Treatment and disposal services	0	0	0	0	0	0	0	0

Alternative 4 (RTD)□Option A (All Slabs) Score = 0.10 of maximum of 1.00	Slabs		Pipelines		UPRs		Other	
	Other Slabs	Priority Slabs	Other Pipelines	Pipelines to 241-Z	Beneath Slabs	Beneath Pipe Trench	Ductwork	Injection Wells
II. Implementability								
A. Technical Feasibility								
a. Construction and operational considerations	-1	-1	0	-1	0	0	-1	0
b. Demonstrated performance/useful life	na	na	na	na	na	na	na	na
c. Adaptable to environmental conditions	na	na	na	na	na	na	na	na
d. Contributes to remedial performance	1	1	1	1	1	1	1	1
e. Can be implemented quickly	-1	-1	-1	-1	-1	-1	-1	0
B. Availability								
a. Equipment	0	0	0	0	0	0	0	0
b. Personnel and services	0	0	0	0	0	0	0	0
c. Treatment and disposal services	1	1	1	1	1	1	1	1

Table 5-5. Implementability Analysis for PFP Sub-Grade Analysis. (Page 3 of 3)

Alternative 4 (RTD)□Option B (Priority Slabs) Score = 0.26 of maximum of 1.00	Slabs		Pipelines		UPRs		Other	
	Other Slabs	Priority Slabs	Other Pipelines	Pipelines to 241-Z	Beneath Slabs	Beneath Pipe Trench	Ductwork	Injection Wells
II. Implementability								
A. Technical Feasibility								
a. Construction and operational considerations	1	-1	0	-1	1	0	-1	0
b. Demonstrated performance/useful life	1	na	na	na	0	na	na	na
c. Adaptable to environmental conditions	na	na	na	na	na	na	na	na
d. Contributes to remedial performance	0	1	1	1	0	1	1	1
e. Can be implemented quickly	1	-1	-1	-1	1	-1	-1	0
B. Availability								
a. Equipment	na	0	0	0	na	0	0	0
b. Personnel and services	1	0	0	0	1	0	0	0
c. Treatment and disposal services	0	1	1	1	0	1	1	1

Alternative 4 (RTD)□Option C (No Slabs) Score = 0.39 of maximum of 1.00	Slabs		Pipelines		UPRs		Other	
	Other Slabs	Priority Slabs	Other Pipelines	Pipelines to 241-Z	Beneath Slabs	Beneath Pipe Trench	Ductwork	Injection Wells
II. Implementability								
A. Technical Feasibility								
a. Construction and operational considerations	1	1	0	1	1	0	1	0
b. Demonstrated performance/useful life	1	1	na	na	0	na	na	na
c. Adaptable to environmental conditions	na	na	na	na	na	na	na	na
d. Contributes to remedial performance	0	0	1	1	0	1	1	1
e. Can be implemented quickly	1	1	-1	-1	1	-1	-1	0
B. Availability								
a. Equipment	na	na	0	0	na	0	0	0
b. Personnel and services	1	1	0	0	1	0	0	0
c. Treatment and disposal services	0	0	1	1	0	1	1	1

Table 5-6. Cost Estimate Input to the Scoring.

Present Worth Cost Summary (Discounted in $1,000)						
Cost Element	Alternative 1 (No Action)	Alternative 2 (S&M)	Alternative 3 (Stabilization)	Alternative 4 (RTD) Option A (All Slabs)	Alternative 4 (RTD) Option B (Priority Slabs)	Alternative 4 (RTD) Option C (No Slabs)
Surveillance and Maintenance	$0	$5,699	$5,699	$5,539	$5,539	$5,699
Capital	$0	$0	$5,519	$54,874	$39,144	$30,527
Sum of Present Worth Costs	**$0**	**$5,699**	**$11,218**	**$60,413**	**$44,683**	**$36,226**

Table 5-7. Steps to Combine the Individual Criteria Scores.

Overall Criteria	Weight	Alternative 1 (No Action)	Alternative 2 (S&M)	Alternative 3 (Stabilization)	Alternative 4 (RTD) Option A (All Slabs)	Alternative 4 (RTD) Option B (Priority Slabs)	Alternative 4 (RTD) Option C (No Slabs)
Step 1. Scoring and Estimating Results Prior to Normalization (from individual factor scoring and cost estimates)							
I. Effectiveness		0.0	0.19	0.28	0.89	0.68	0.64
II. Implementability		0.0	0.55	0.33	0.10	0.26	0.39
III. Cost (PW, $1,000s)		$0	$5,699	$11,218	$60,413	$44,683	$36,226
Step 2. Normalized Results (Results in Step 1 are normalized to 100 for each criterion row)							
I. Effectiveness		0.0	7.03	10.35	33.20	25.39	24.02
II. Implementability		0.0	33.44	20.38	6.37	15.92	23.89
III. Cost		0.0	52.99	26.92	5.00	6.76	8.34
Note: Lower cost gets higher score by applying inverse of cost prior to normalization.							
Step 3 Alternative Analysis Results (Sum of the weights = 100% so that the bottom row score totals 100)							
I. Effectiveness	33%	0.0	2.34	3.45	11.07	8.46	8.01
II. Implementability	33%	0.0	11.15	6.79	2.12	5.31	7.96
III. Cost	33%	0.0	17.66	8.97	1.67	2.25	2.78
	Score	**0.0**	**31.2**	**19.2**	**14.9**	**16.0**	**18.7**

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6.0 RECOMMENDED ALTERNATIVE

The results provided in Chapter 5.0 support the selection of Alternative 2 (Surveillance and Maintenance) as the most efficient approach for reduction of risk associated with the PFP sub-grade structures and installations. Although some of the other alternatives are generally more effective, the cost and implementability of these alternatives contribute to reduce overall efficiency.

Given the generally stable nature of the remaining contaminants associated with the sub-grade structures and installations, the Surveillance and Maintenance alternative is the recommended interim action proposed by this analysis.

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7.0 REFERENCES

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10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations*, as amended.

29 CFR 1910, "Occupational Safety and Health Standards," *Code of Federal Regulations*, as amended.

36 CFR 800, "Protection of Historic Properties," *Code of Federal Regulations*, as amended.

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," *Code of Federal Regulations*, as amended.

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40 CFR 260-268, "Hazardous Waste Management System," *Code of Federal Regulations*, as amended.

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ATTACHMENT 1

SITES HISTORICALLY ASSOCIATED WITH THE PFP COMPLEX

The following table summarizes the sites historically associated with the PFP complex and provides a brief rationale for inclusion or exclusion of from the scope of this analysis.

Table A1-1. Sites Historically Associated with the PFP Complex. (5 Pages)

Site ID	Description	In PFP Sub-Grade Analysis?[1]	Comments
BUILDING SLAB			
225-WC	Wastewater Sampling Facility	No, as building slab is not contaminated.	
231-Z	Pu Metallurgy Lab	No, as building is not part of the PFP Complex.	Reducing building to slab-on-grade and determining follow on actions are the responsibility of Central Plateau D&D.
232-Z	Contaminated Waste Recovery Process Facility	Yes, as building slab and ductwork are contaminated.	Structure removed to slab-on-grade through DOE/RL-2003-29.
234-5Z	Plutonium Finishing Plant	Yes, as building slab/trenches/tunnels are contaminated.	Includes various pipe trenches and basement tunnels.
234-5ZA	Change Room Addition	No, as building slab is not contaminated.	
234-ZB	Waste Material Storage Building	No, as building slab is not contaminated.	
234-ZC	Waste Drum Storage Facility	No, as building slab is not contaminated.	
236-Z	Plutonium Reclamation Facility	Yes, as building slab and ductwork are contaminated.	
241-Z	Tank Farm Waste Disposal Building	Yes, as tanks and pit areas are highly contaminated.	Also known as the Waste Storage and Treatment Facility.
241-ZA	Sample Building	Yes, as building slab is contaminated.	
241-ZB	Sodium Hydroxide Tank	No, as building slab is not contaminated.	
241-ZG	Change Facility	No, as building slab is not contaminated.	
241-Z-RB	Retention Basins	Yes, as concrete basins is contaminated.	Also known as the 207-Z retention basin. Recently filled with controlled-density fill.
242-Z	Waste Treatment Facility	Yes, as building slab is contaminated.	
242-ZA	Monitoring Building	No, as building slab is not contaminated.	
243-Z	Low-Level Waste Treatment Facility	Yes, as building slab is contaminated.	
243-ZA	Low-Level Waste Storage Facility	Yes, as building slab and sump pit are contaminated.	
243-ZB	Cooling Towers and Concrete Pad	No, as concrete pad is not contaminated.	
2503-Z	Electrical Switchyard	No, as concrete pad is not contaminated.	
252-Z-1	Electrical Substation	No, as concrete pad is not contaminated.	

Table A1-1. Sites Historically Associated with the PFP Complex. (5 Pages)

Site ID	Description	In PFP Sub-Grade Analysis?[1]	Comments
270-Z	Operations and Support Facility	No, as building slab is not contaminated.	
2701-ZA	Central Alarm Station Facility	No, as building slab is not contaminated.	
2701-ZD	Badge house	No, as building slab is not contaminated.	
2702-Z	Microwave Tower and Communications Support Building	No, as building slab is not contaminated.	
2704-Z	Safeguards and Security Building	No, as building slab is not contaminated.	
2705-Z	Operations Control Facility	No, as building slab is not contaminated.	
2712-Z	Stack Monitoring Station	No, as building slab is not contaminated.	
2721-Z	Emergency Generator Building	No, as building slab is not contaminated.	
2727-Z	Supply Storage Building	No, as building slab is not contaminated.	
2729-Z	Maintenance Storage Building	No, as building slab is not contaminated..	
2731-Z	Plutonium Drum Storage Building	No, as building slab is not contaminated.	
2731-ZA	Container Storage Building	No, as building slab is not contaminated.	
2734-ZA	Gas Bottle Storage	No, as building slab is not contaminated.	
2734-ZB	Gas Bottle Storage	No, as building slab is not contaminated.	
2734-ZC	Gas Bottle Storage	No, as building slab is not contaminated.	
2734-ZD	Gas Bottle Storage	No, as building slab is not contaminated.	
2734-ZF	Gas Bottle Storage	No, as building slab is not contaminated.	
2734-ZG	Gas Bottle Storage	No, as building slab is not contaminated.	
2734-ZH	Gas Bottle Storage	No, as building slab is not contaminated.	
2734-ZJ	Liquid Nitrogen Storage and Supply	No, as building slab is not contaminated.	
2734-ZK	Gas Bottle Storage	No, as building slab is not contaminated.	
2734-ZL	Gas Bottle Storage	No, as building slab is not contaminated.	
2735-Z	Bulk Chemical Storage Tanks	No, as building slab is not contaminated.	
2736-Z	Plutonium Storage Building	Yes, as building slab is contaminated.	
2736-ZA	Plutonium Storage	Yes, as building slab is	

Table A1-1. Sites Historically Associated with the PFP Complex. (5 Pages)

Site ID	Description	In PFP Sub-Grade Analysis?[1]	Comments
	Ventilation Structure	contaminated.	
2736-ZB	Plutonium Storage Support Facility	Yes, as building slab is contaminated.	
2736-ZC	Cargo Restraint Transport Dock	No, as concrete pad is not contaminated.	
2736-ZD	Vault-EBR II Casks	No, as building slab is not contaminated.	
2904-ZA	Radiation and Flow Monitoring Station	Yes, as building slab is contaminated.	Capped riser is considered highly internally contaminated.
2904-ZB	Monitoring Building	Yes, as building slab is contaminated.	Six capped risers are potentially internally contaminated.
291-Z	Exhaust Air Filter Building	Yes, as building slab is contaminated.	Includes below-grade fan house and sub-grade ductwork between 291-Z Building and 291-Z Stack.
291-Z-001	Stack	Yes, as building slab is contaminated.	Includes below-grade portion of the stack structure.
Waste Disposal Installations			
216-Z-1A	Tile Field	Only the waste pipelines to this installation are included in this analysis.	The installation is addressed by the 200-PW-1 OU.
216-Z-1D	Ditch	No, see 216-Z-20 Crib.	The installation is addressed by the 200-CW-5 OU. Co-located with 216-Z-20 Crib.
216-Z-1	Crib	Only the waste pipelines to this installation are included in this analysis.	The installation is addressed by the 200-PW-1 OU.
216-Z-2	Crib	Only the waste pipelines to this installation are included in this analysis.	The installation is addressed by the 200-PW-1 OU.
216-Z-3	Crib	Only the waste pipelines to this installation are included in this analysis.	The installation is addressed by the 200-PW-1 OU.
216-Z-4	Trench	No, as this trench is associated with the 231-Z building.	The installation is addressed by the 200-PW-6 OU.
216-Z-5	Crib	No, as this crib is associated with the 231-Z building.	The installation is addressed by the 200-PW-6 OU.
216-Z-6	Crib	No, as this crib is associated with the 231-Z building.	The installation is addressed by the 200-PW-6 OU.
216-Z-7	Crib	No, as this crib is associated with the 231-Z building.	The installation is addressed by the 200-LW-2 OU.
216-Z-8	French Drain	No, as this French drain is addressed by the 200-PW-6 OU.	This installation and waste pipelines between it and the 241-Z-8 Settling tank are addressed by the 200-PW-6 OU.
216-Z-9	Crib	Only the waste pipelines to this installation are included in this analysis.	The installation is addressed by the 200-PW-1 OU.
216-Z-10	Reverse Well	No, as this reverse well is associated with the 231-Z building.	The installation is addressed by the 200-PW-6 OU.

Table A1-1. Sites Historically Associated with the PFP Complex. (5 Pages)

Site ID	Description	In PFP Sub-Grade Analysis?[1]	Comments
216-Z-11	Ditch	No, see 216-Z-20 Crib.	The installation is addressed by the 200-CW-5 OU. Co-located with 216-Z-20 Crib. Replaced 216-Z-1D Ditch in 1959.
216-Z-12	Crib	Only the waste pipelines to this installation are included in this analysis.	The installation is addressed by the 200-PW-1 OU.
216-Z-13	French Drain	Yes, due to its location, the French Drain and inlet pipeline(s) are included in this analysis.	This installation is addressed by the 200-MW-1 OU.
216-Z-14	French Drain	Yes, due to its location, the French Drain and inlet pipeline(s) are included in this analysis.	This installation is addressed by the 200-MW-1 OU.
216-Z-15	French Drain	Yes, due to its location, the French Drain and inlet pipeline(s) are included in this analysis.	This installation is addressed by the 200-MW-1 OU.
216-Z-16	Crib	No, as this crib is associated with the 231-Z building.	The installation is addressed by the 200-LW-2 OU.
216-Z-17	Trench	No, as this trench is associated with the 231-Z building.	The installation is addressed by the 200-LW-2 OU.
216-Z-18	Crib	No, as this crib is addressed by the 200-PW-6 OU.	This installation and waste pipelines between it and the 216-Z-1A Tile Field, 216-Z-1 Crib and 216-Z-2 Crib are addressed by the 200-PW-1 OU.
216-Z-19	Ditch	No, see 216-Z-20 Crib.	The installation is addressed by the 200-CW-5 OU. Co-located with 216-Z-20 Crib. Replaced 216-Z-11 Ditch in 1971.
216-Z-20	Crib	Only the waste pipelines to this installation are included in this analysis.	The installation is addressed by the 200-CW-5 OU.
216-Z-21	Seepage Basin	No, as the seepage basin and its inlet pipeline are not contaminated.	This installation is addressed by the 200-MW-1 OU.
Diversion Box No. 1	Diversion Box	Yes, as diversion box is contaminated.	Also known as 200-W-58. Diversion box is address by the 200-IS-1 OU.
Diversion Box No. 2	Diversion Box	Yes, as diversion box is contaminated.	Also known as 200-W-59. Diversion box is addressed by the 200-IS-1 OU.
241-Z-8	Settling Tank	Only the waste pipelines to this installation are included in this analysis.	The installation is addressed by the 200-PW-6 OU.
241-Z-361	Settling Tank	Only the waste pipelines to this installation are included in this analysis.	The installation was evaluated through DOE/RL-2003-52 and is addressed by the 200-PW-1 OU.
2607-WA	Septic Tank and Drain Field	No, as this septic tank and drain field are not contaminated.	This installation is addressed by the 200-ST-1 OU.
2607-WB	Septic Tank and	No, as this septic tank and drain	This installation is addressed by the

Table A1-1. Sites Historically Associated with the PFP Complex. (5 Pages)

Site ID	Description	In PFP Sub-Grade Analysis?[1]	Comments
	Drain Field	field are not contaminated.	200-ST-1 OU.
2607-W8	Septic Tank and Drain Field	No, as this septic tank and drain field are not contaminated.	This installation is addressed by the 200-ST-1 OU.
2607-Z	Septic Tank and Drain Field	No, as this septic tank and drain field are not contaminated.	This installation is addressed by the 200-ST-1 OU.
2607-Z-1	Septic Tank and Drain Field	No, as this septic tank and drain field are not contaminated.	This installation is addressed by the 200-ST-1 OU
2607-Z8	Septic Tank and Drain Field	No, as this septic tank and drain field are not contaminated.	This installation is addressed by the 200-ST-1 OU

[1] This analysis discusses actions recommended to address the contaminated PFP structures and installations. Remedial actions for in-scope structures and installations will be addressed by Central Plateau D&D.

ATTACHMENT 2

ILLUSTRATION OF MAJOR PROCESS PIPELINES AND THE FACILITIES SERVED OVER PFP'S OPERATING LIFE

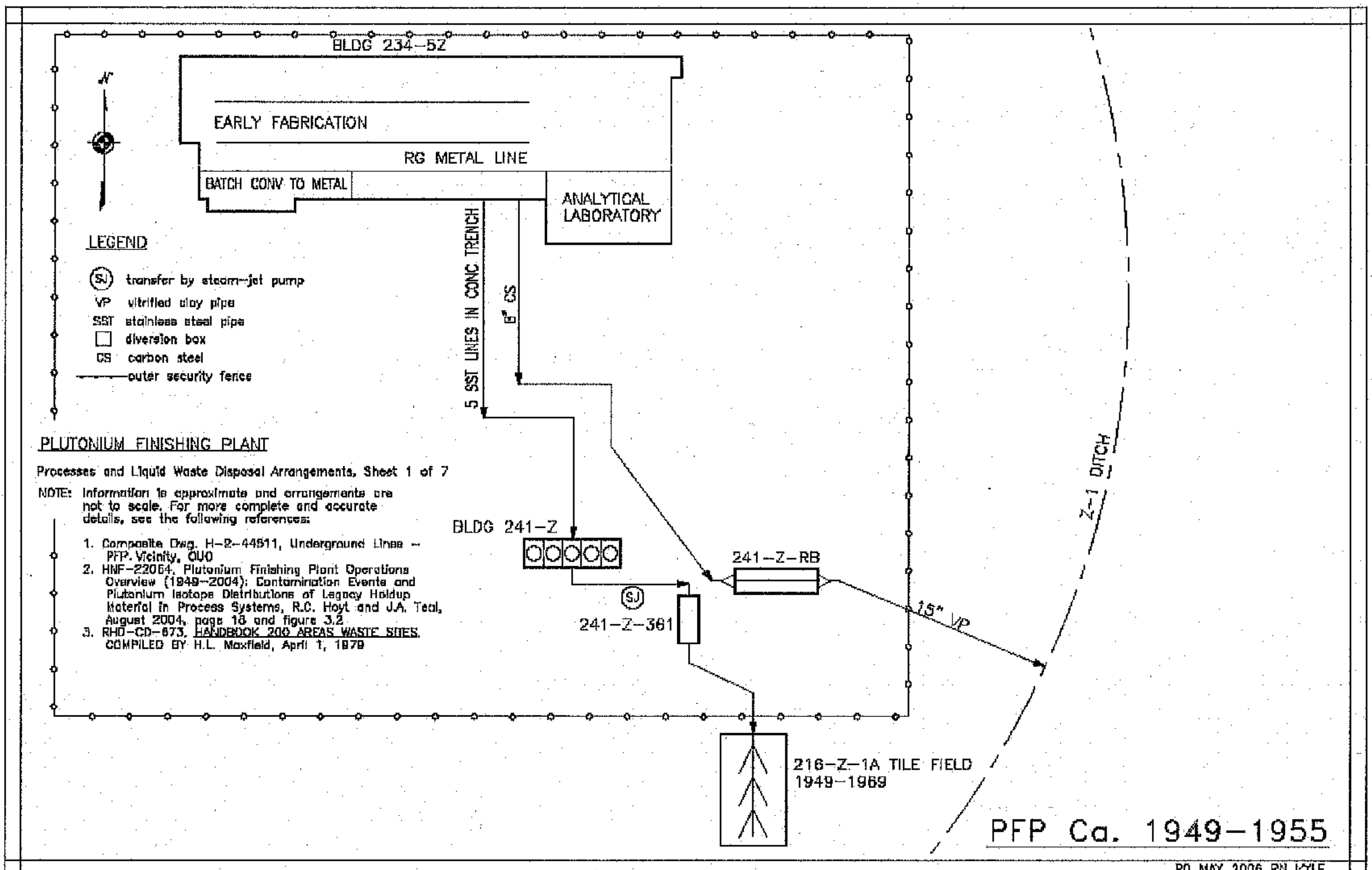
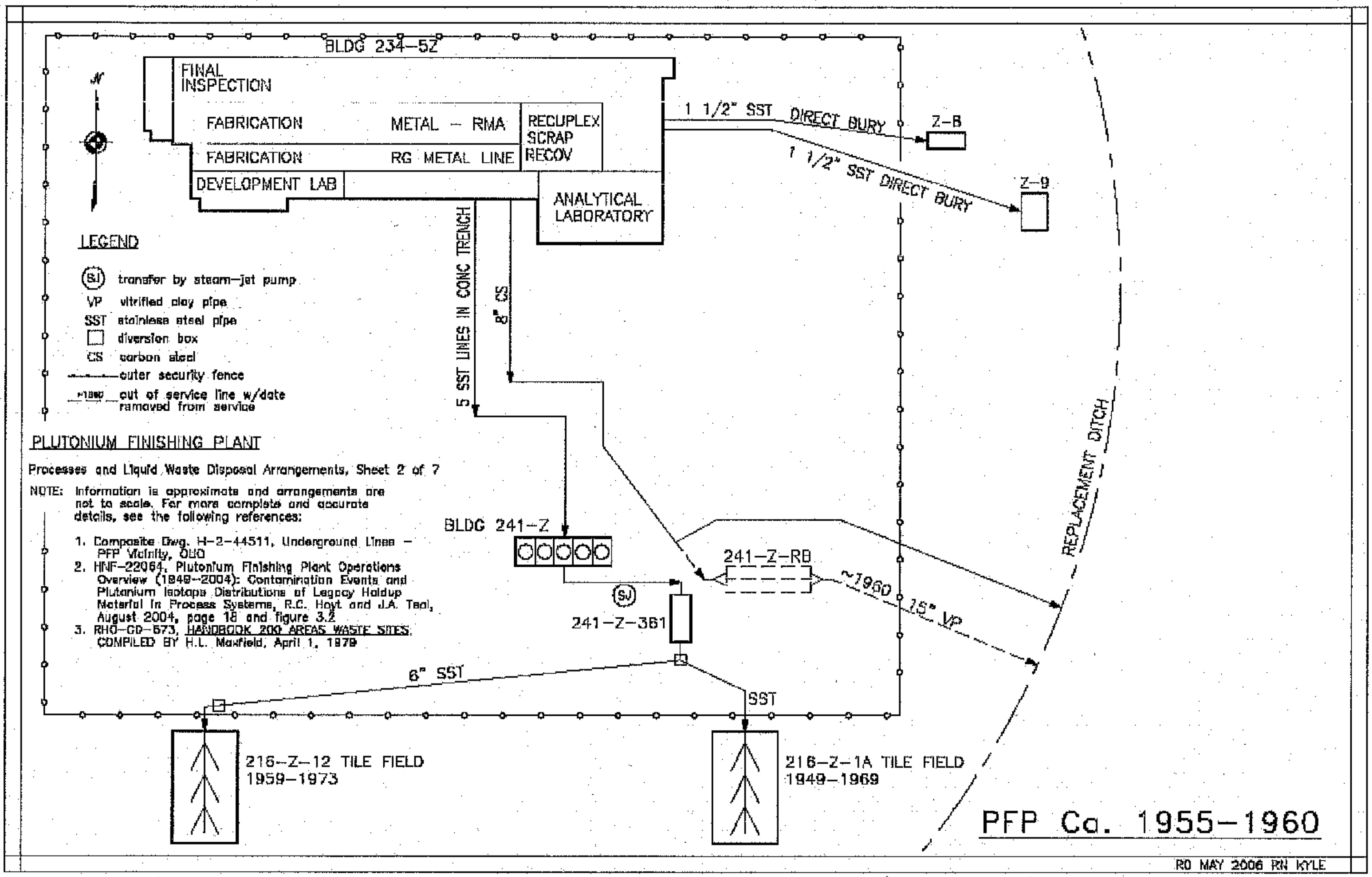

BLDG 234-5Z
N
EARLY FABRICATION
RG METAL LINE
BATCH CONV TO METAL
ANALYTICAL LABORATORY
LEGEND
SJ transfer by steam-jet pump
VP vitrified clay pipe
SST stainless steel pipe
diversion box
CS carbon steel
outer security fence
5 SST LINES IN CONC TRENCH
6" CS
PLUTONIUM FINISHING PLANT
Processes and Liquid Waste Disposal Arrangements, Sheet 1 of 7
NOTE: Information is approximate and arrangements are not to scale. For more complete and accurate details, see the following references:
1. Composite Dwg. H-2-44511, Underground Lines -- PFP Vicinity, OUO
2. HNF-22054, Plutonium Finishing Plant Operations Overview (1949-2004): Contamination Events and Plutonium Isotope Distributions of Legacy Holdup Material in Process Systems, R.C. Hoyt and J.A. Teal, August 2004, page 18 and figure 3.2
3. RHO-CD-673, HANDBOOK 200 AREAS WASTE SITES, COMPILED BY H.L. Maxfield, April 1, 1979
BLDG 241-Z
SJ
241-Z-361
241-Z-RB
15" VP
Z-1 DITCH
216-Z-1A TILE FIELD
1949-1969
PFP Ca. 1949-1955
R0 MAY 2006 RN KYLE

Figure A2-1.


BLDG 234-5Z
N
FINAL INSPECTION
FABRICATION
METAL – RMA
RECUPLEX SCRAP RECOV
FABRICATION
RG METAL LINE
DEVELOPMENT LAB
ANALYTICAL LABORATORY
1 1/2" SST DIRECT BURY
Z-8
1 1/2" SST DIRECT BURY
Z-9
5 SST LINES IN CONC TRENCH
8" CS
LEGEND
SJ transfer by steam-jet pump
VP vitrified clay pipe
SST stainless steel pipe
diversion box
CS carbon steel
outer security fence
~1960 out of service line w/date removed from service
PLUTONIUM FINISHING PLANT
Processes and Liquid Waste Disposal Arrangements, Sheet 2 of 7
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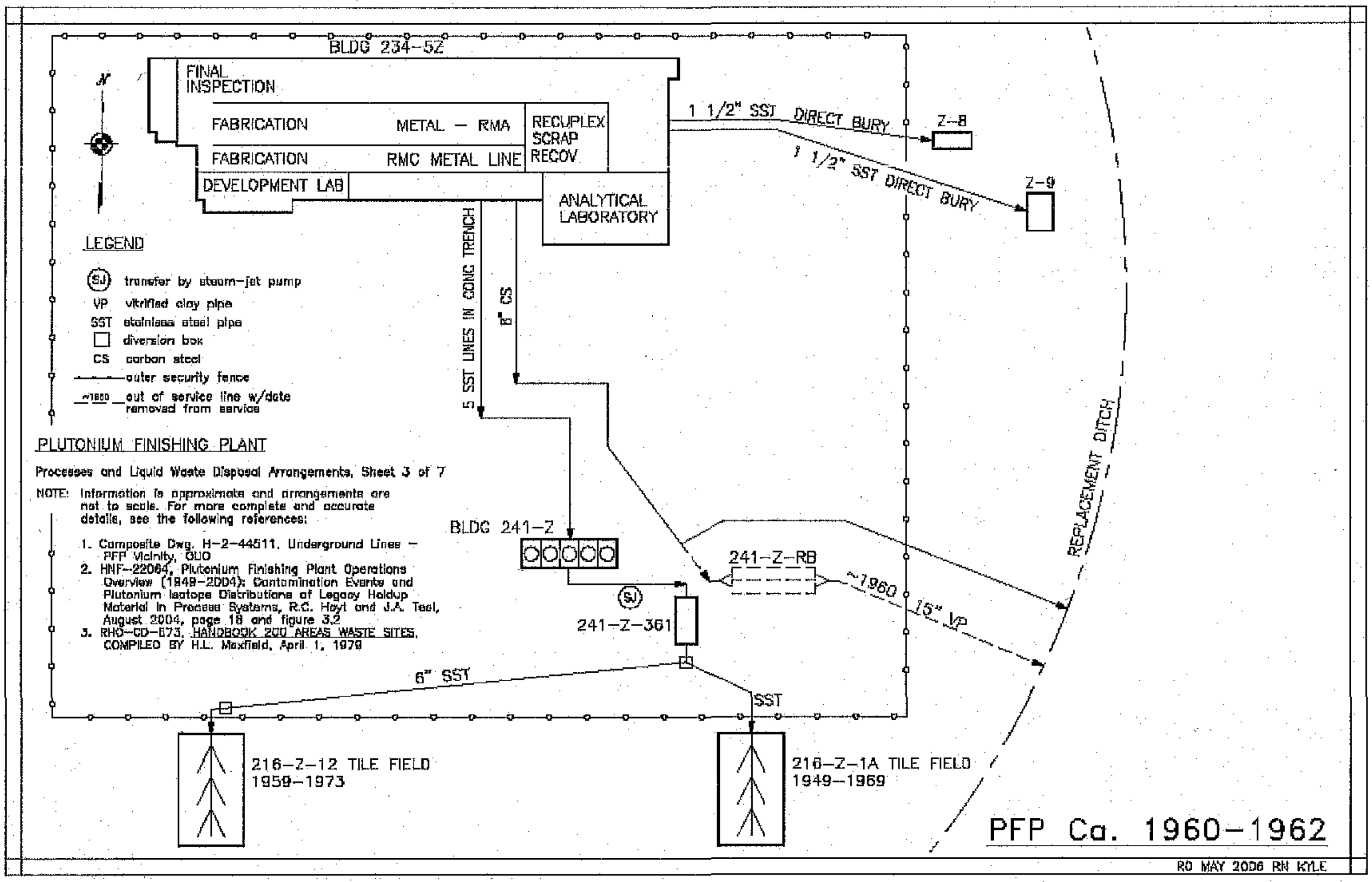
3. RHO-CD-673, HANDBOOK 200 AREAS WASTE SITES, COMPILED BY H.L. Maxfield, April 1, 1979
BLDG 241-Z
241-Z-RB
~1960
15" VP
SJ
241-Z-361
REPLACEMENT DITCH
6" SST
SST
216-Z-12 TILE FIELD
1959–1973
216-Z-1A TILE FIELD
1949–1969
PFP Ca. 1955–1960
R0 MAY 2006 RN KYLE

Figure A2-2.


BLDG 234-5Z
N
FINAL INSPECTION
FABRICATION
METAL — RMA
RECUPLEX SCRAP RECOV
FABRICATION
RMC METAL LINE
DEVELOPMENT LAB
ANALYTICAL LABORATORY
1 1/2" SST DIRECT BURY
Z-8
1 1/2" SST DIRECT BURY
Z-9
5 SST LINES IN CONC TRENCH
6" CS
LEGEND
SJ transfer by steam-jet pump
VP vitrified clay pipe
SST stainless steel pipe
diversion box
CS carbon steel
outer security fence
~1960 out of service line w/date removed from service
PLUTONIUM FINISHING PLANT
Processes and Liquid Waste Disposal Arrangements, Sheet 3 of 7
NOTE: Information is approximate and arrangements are not to scale. For more complete and accurate details, see the following references:
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2. HNF-22064, Plutonium Finishing Plant Operations Overview (1949-2004): Contamination Events and Plutonium Isotope Distributions of Legacy Holdup Material in Process Systems, R.C. Hoyt and J.A. Teal, August 2004, page 18 and figure 3.2
3. RHO-CD-673, HANDBOOK 200 AREAS WASTE SITES, COMPILED BY H.L. Maxfield, April 1, 1979
BLDG 241-Z
241-Z-RB
~1960
15" VP
REPLACEMENT DITCH
SJ
241-Z-361
6" SST
SST
216-Z-12 TILE FIELD
1959-1973
216-Z-1A TILE FIELD
1949-1969
PFP Ca. 1960-1962
RO MAY 2006 RN KYLE

Figure A2-3.

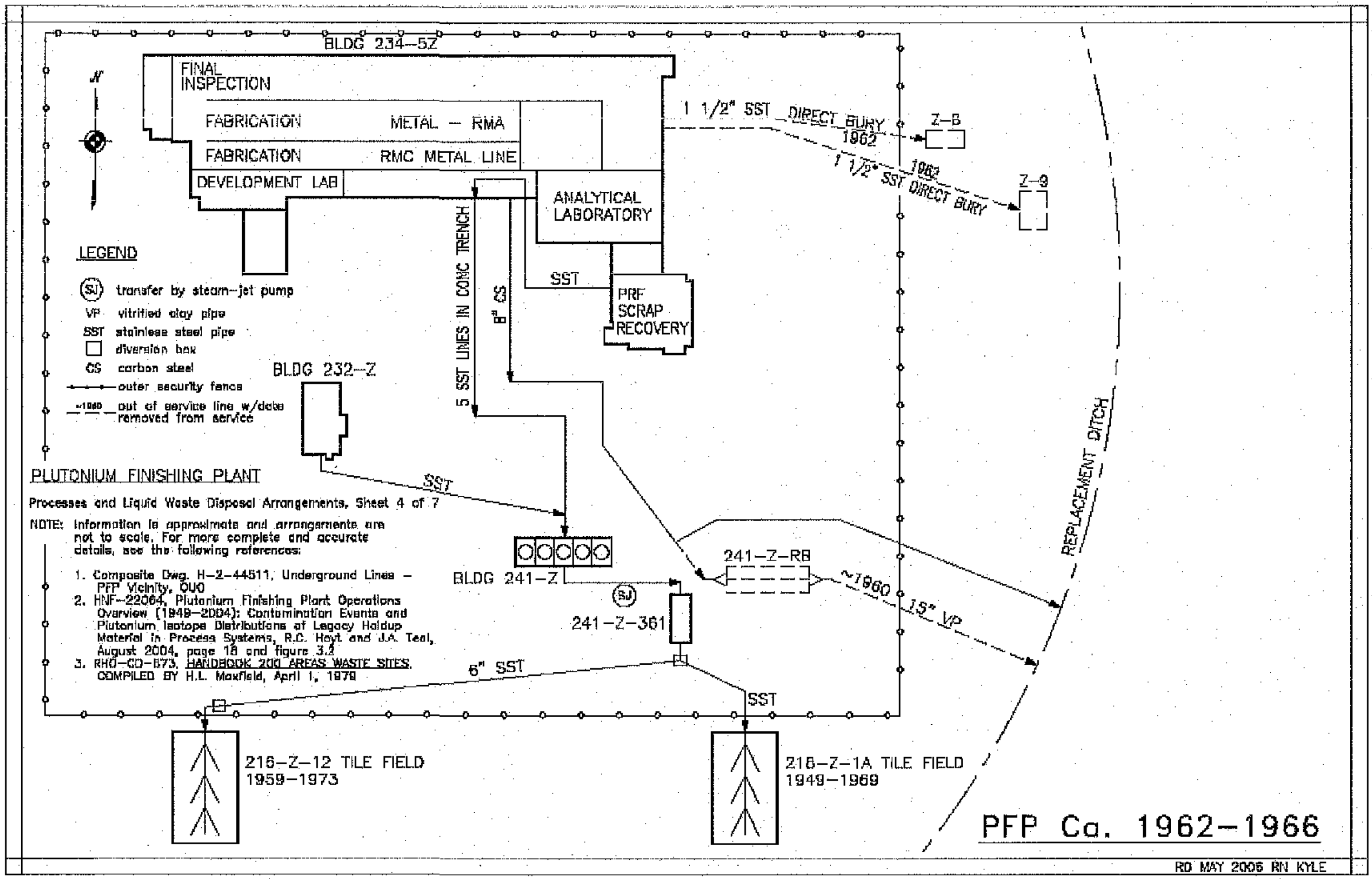
BLDG 234-5Z
FINAL INSPECTION
FABRICATION
METAL - RMA
FABRICATION
RMC METAL LINE
DEVELOPMENT LAB
ANALYTICAL LABORATORY
PRF SCRAP RECOVERY
SST
8" CS
5 SST LINES IN CONC TRENCH
1 1/2" SST DIRECT BURY 1962
Z-8
1962 1 1/2" SST DIRECT BURY
Z-9
REPLACEMENT DITCH
LEGEND
SJ transfer by steam-jet pump
VP vitrified clay pipe
SST stainless steel pipe
diversion box
CS carbon steel
outer security fence
~1960 out of service line w/date removed from service
BLDG 232-Z
SST
PLUTONIUM FINISHING PLANT
Processes and Liquid Waste Disposal Arrangements, Sheet 4 of 7
NOTE: Information is approximate and arrangements are not to scale. For more complete and accurate details, see the following references:
1. Composite Dwg. H-2-44511, Underground Lines - PFP Vicinity, OUO
2. HNF-22064, Plutonium Finishing Plant Operations Overview (1949-2004): Contamination Events and Plutonium Isotope Distributions of Legacy Holdup Material in Process Systems, R.C. Hoyt and J.A. Teal, August 2004, page 18 and figure 3.2
3. RHO-CD-673, HANDBOOK 200 AREAS WASTE SITES, COMPILED BY H.L. Maxfield, April 1, 1979
BLDG 241-Z
SJ
241-Z-361
241-Z-R8
~1960
15" VP
6" SST
SST
216-Z-12 TILE FIELD 1959-1973
216-Z-1A TILE FIELD 1949-1969
PFP Ca. 1962-1966
RD MAY 2006 RN KYLE

Figure A2-4.

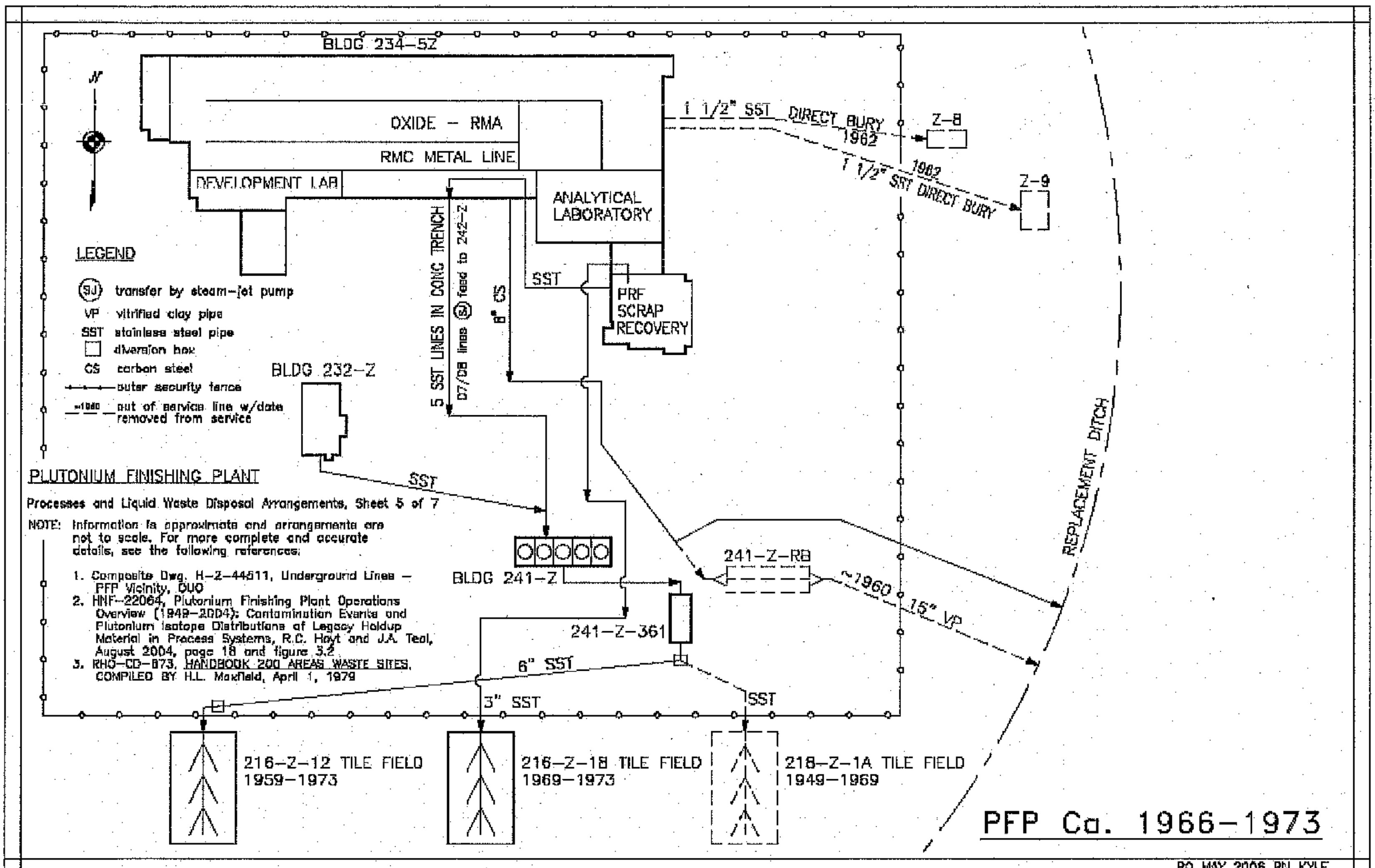
BLDG 234-5Z
OXIDE - RMA
RMC METAL LINE
DEVELOPMENT LAB
ANALYTICAL LABORATORY
PRF SCRAP RECOVERY
1 1/2" SST DIRECT BURY 1962
Z-8
1 1/2" SST DIRECT BURY 1962
Z-9
5 SST LINES IN CONC TRENCH
D7/D8 lines (SJ) feed to 242-Z
8" CS
SST
N
LEGEND
(SJ) transfer by steam-jet pump
VP vitrified clay pipe
SST stainless steel pipe
diversion box
CS carbon steel
outer security fence
out of service line w/date removed from service
BLDG 232-Z
SST
PLUTONIUM FINISHING PLANT
Processes and Liquid Waste Disposal Arrangements, Sheet 5 of 7
NOTE: Information is approximate and arrangements are not to scale. For more complete and accurate details, see the following references:
1. Composite Dwg. H-2-44511, Underground Lines — PFP Vicinity, OUO
2. HNF-22064, Plutonium Finishing Plant Operations Overview (1949-2004): Contamination Events and Plutonium Isotope Distributions of Legacy Holdup Material in Process Systems, R.C. Hoyt and J.A. Teal, August 2004, page 18 and figure 3.2
3. RHO-CD-673, HANDBOOK 200 AREAS WASTE SITES, COMPILED BY H.L. Maxfield, April 1, 1979
BLDG 241-Z
241-Z-RB
~1960
15" VP
241-Z-361
6" SST
3" SST
SST
REPLACEMENT DITCH
216-Z-12 TILE FIELD 1959-1973
216-Z-18 TILE FIELD 1969-1973
216-Z-1A TILE FIELD 1949-1969
PFP Ca. 1966-1973
RO MAY 2006 RN KYLE

Figure A2-5.

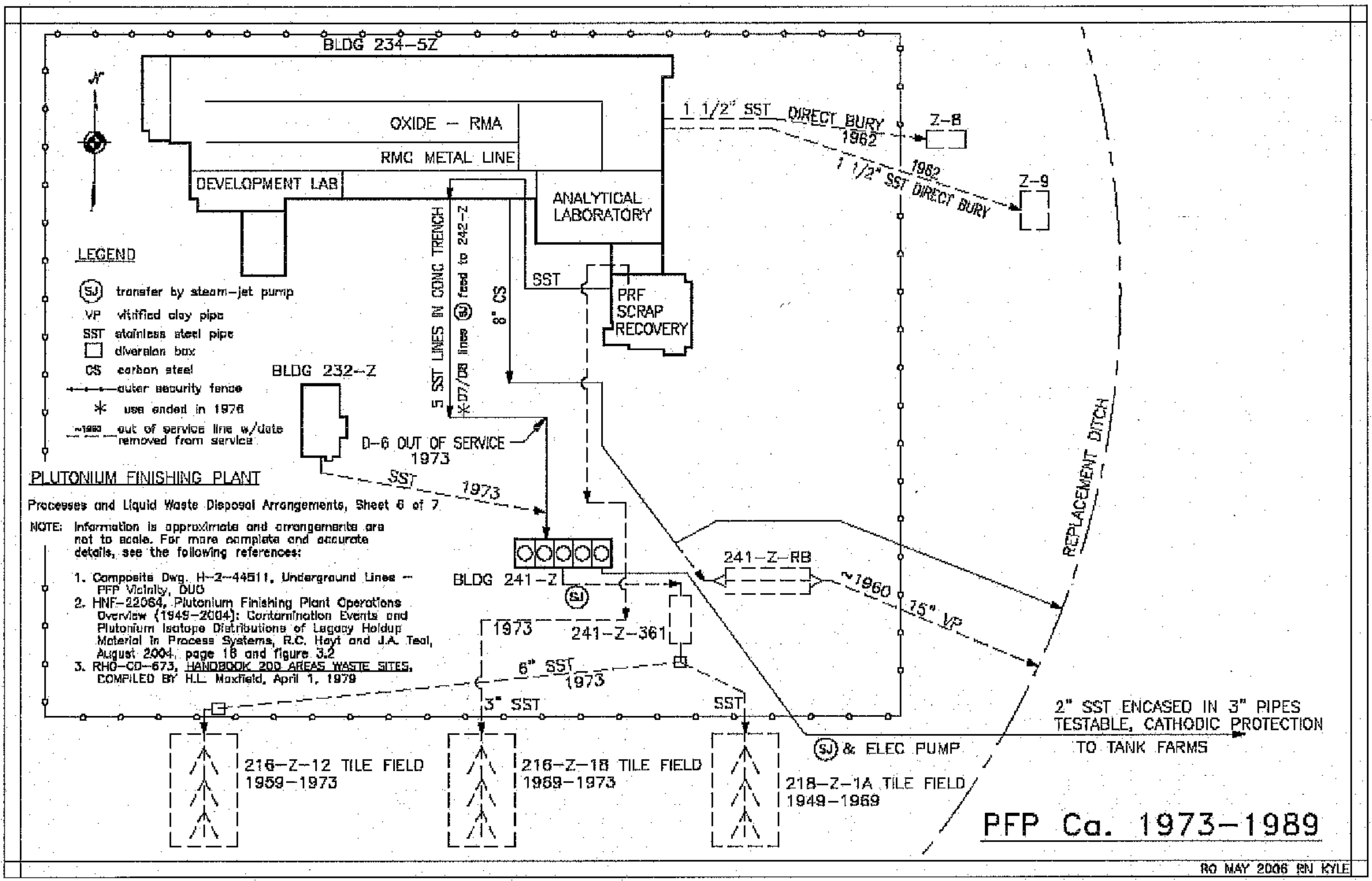
BLDG 234-5Z
OXIDE – RMA
RMC METAL LINE
DEVELOPMENT LAB
ANALYTICAL LABORATORY
PRF SCRAP RECOVERY
SST
8" CS
5 SST LINES IN CONC TRENCH
(SJ) feed to 242-Z
*D7/D8 lines
1 1/2" SST DIRECT BURY 1962
1 1/2" SST DIRECT BURY 1962
Z-8
Z-9
LEGEND
(SJ) transfer by steam-jet pump
VP vitrified clay pipe
SST stainless steel pipe
diversion box
CS carbon steel
outer security fence
* use ended in 1976
~1960 out of service line w/date removed from service
BLDG 232-Z
D-6 OUT OF SERVICE 1973
SST 1973
PLUTONIUM FINISHING PLANT
Processes and Liquid Waste Disposal Arrangements, Sheet 6 of 7
NOTE: Information is approximate and arrangements are not to scale. For more complete and accurate details, see the following references:
1. Composite Dwg. H-2-44511, Underground Lines – PFP Vicinity, DUO
2. HNF-22064, Plutonium Finishing Plant Operations Overview (1949–2004): Contamination Events and Plutonium Isotope Distributions of Legacy Holdup Material in Process Systems, R.C. Hoyt and J.A. Teal, August 2004, page 18 and figure 3.2
3. RHO-CD-673, HANDBOOK 200 AREAS WASTE SITES, COMPILED BY H.L. Maxfield, April 1, 1979
BLDG 241-Z
(SJ)
241-Z-RB
~1960
15" VP
REPLACEMENT DITCH
1973
241-Z-361
6" SST 1973
3" SST
SST
216-Z-12 TILE FIELD 1959–1973
216-Z-18 TILE FIELD 1969–1973
216-Z-1A TILE FIELD 1949–1969
(SJ) & ELEC PUMP
2" SST ENCASED IN 3" PIPES TESTABLE, CATHODIC PROTECTION TO TANK FARMS
PFP Ca. 1973–1989
RO MAY 2006 RN KYLE

Figure A2-6.

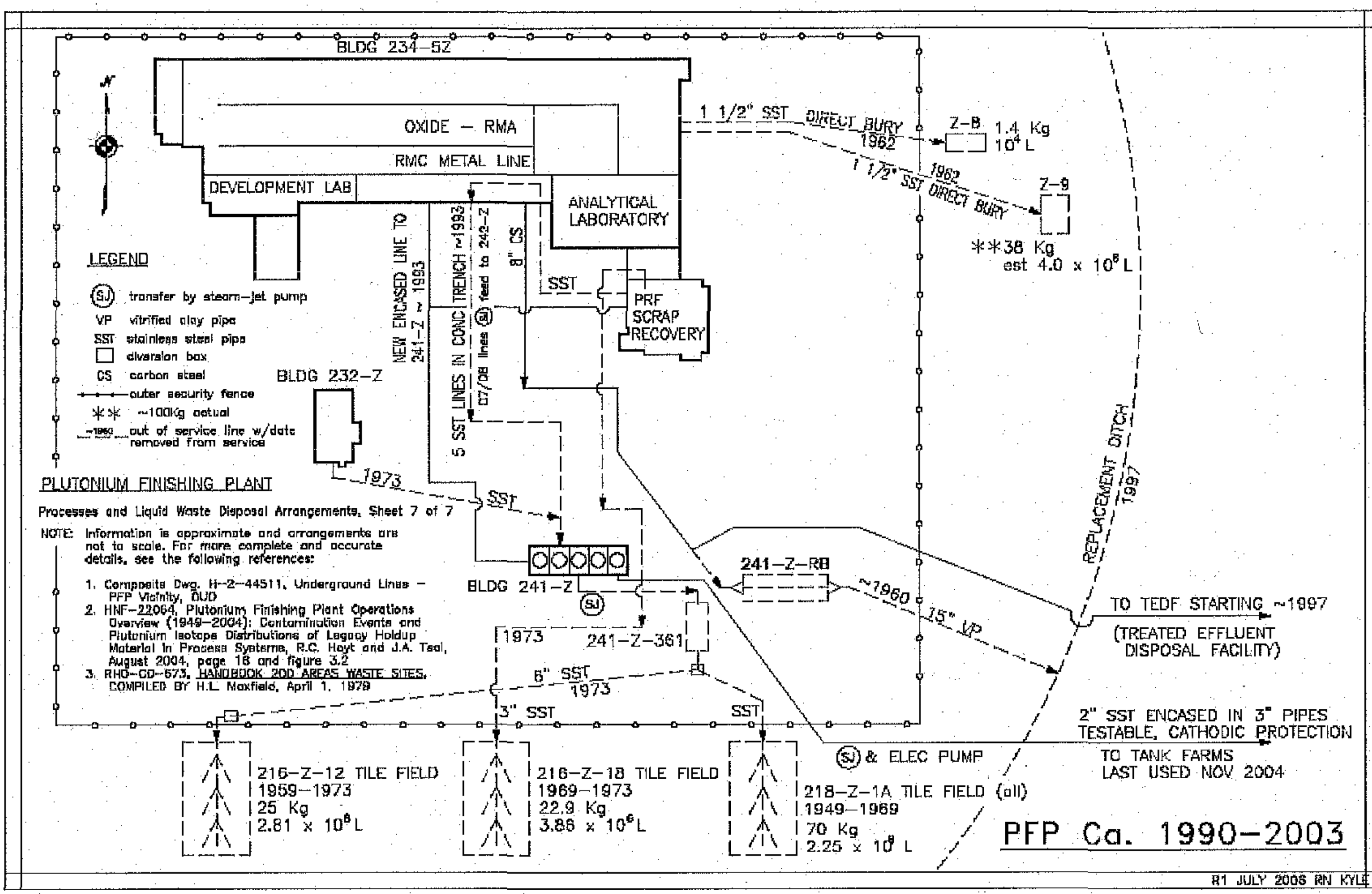
BLDG 234-5Z
OXIDE — RMA
RMC METAL LINE
DEVELOPMENT LAB
ANALYTICAL LABORATORY
PRF SCRAP RECOVERY
N
LEGEND
(SJ) transfer by steam-jet pump
VP vitrified clay pipe
SST stainless steel pipe
diversion box
CS carbon steel
outer security fence
** ~100Kg actual
1960 out of service line w/date removed from service
BLDG 232-Z
NEW ENCASED LINE TO 241-Z ~ 1993
5 SST LINES IN CONC TRENCH ~1993
07/08 lines (SJ) feed to 242-Z
8" CS
SST
1 1/2" SST DIRECT BURY 1962
Z-8 1.4 Kg 10⁴ L
1 1/2" SST DIRECT BURY 1962
Z-9
**38 Kg est 4.0 x 10⁶ L
REPLACEMENT DITCH 1997
PLUTONIUM FINISHING PLANT
Processes and Liquid Waste Disposal Arrangements, Sheet 7 of 7
NOTE: Information is approximate and arrangements are not to scale. For more complete and accurate details, see the following references:
1. Composite Dwg. H-2-44511, Underground Lines — PFP Vicinity, DUD
2. HNF-22064, Plutonium Finishing Plant Operations Overview (1949—2004): Contamination Events and Plutonium Isotope Distributions of Legacy Holdup Material in Process Systems, R.C. Hoyt and J.A. Teal, August 2004, page 18 and figure 3.2
3. RHO-CD-673, HANDBOOK 200 AREAS WASTE SITES, COMPILED BY H.L. Maxfield, April 1, 1979
1973 SST
BLDG 241-Z
(SJ)
241-Z-RB
~1960
15" VP
TO TEDF STARTING ~1997
(TREATED EFFLUENT DISPOSAL FACILITY)
1973
241-Z-361
6" SST 1973
3" SST
SST
2" SST ENCASED IN 3" PIPES TESTABLE, CATHODIC PROTECTION
TO TANK FARMS LAST USED NOV 2004
(SJ) & ELEC PUMP
216-Z-12 TILE FIELD 1959—1973 25 Kg 2.81 x 10⁶ L
216-Z-18 TILE FIELD 1969—1973 22.9 Kg 3.86 x 10⁶ L
216-Z-1A TILE FIELD (all) 1949—1969 70 Kg 2.25 x 10⁸ L
PFP Ca. 1990—2003
R1 JULY 2006 RN KYLE

Figure A2-7

ATTACHMENT 3

COST ESTIMATE SENSITIVITY ANALYSES

COST ESTIMATE SENSITIVITY ANALYSIS

Summary

The relative costs of the alternatives in this analysis are a significant factor in arriving at a conclusion that the Surveillance and Maintenance alternative is preferred. Therefore, sensitivity analyses have been conducted to test cost conservatisms to assess if results are grossly skewed towards the recommended alternative. For that purpose, the following three factors have been evaluated and are presented here:

- The cost of mobilization and demobilization has been included in each activity associated with Alternatives 3 and 4 Options A, B, and C, which results in a conservatively high estimate. This was tested by reducing these costs by 75% for Alternatives 3 and 4 A, B, and C.

- The estimate assumes that most S&M activities continue to apply to the stabilization and RTD alternatives, which perhaps increases their costs more than would actually be experienced. This was tested by reducing these costs to zero for Alternatives 4 A, B, and C, reasoning that stabilization does not remove much contaminant source.

- The potential that: a) the overall estimate for stabilization and RTD may be conservatively very high, or b) use of inverse of costs for grading may create too low a score for stabilization or RTD was evaluated. Both of these cases were tested in one analysis by reducing the importance of the Cost criterion, relative to the other criteria, from 33% to 10%.

The sensitivity analysis results are summarized in Table A3-1. In all cases, the Surveillance and Maintenance alternative has the highest ranking, as it does in the base case, as shown in the Alternative 2 column. The basic reason for the unchanged conclusion is the cost for stabilization and RTD activities are considerably higher than the costs for S&M activities, and that the Effectiveness and Implementability criteria scorings remain unchanged.

Mobilization/Demobilization Costs Variation

Mobilization/Demobilization costs are $1M for Alternative 3 and $9M to $6M for Alternative 4 Options A to C, respectively. The reason is that the cost of mobilization and demobilization has been included in each activity associated with these alternatives. In reality, while conducting any of this work, project managers would strive to combine activities and lower mobilization cost, which is quite achievable since the work discussed is at PFP.

This sensitivity analysis reduced Alternatives 3 and 4 mobilization cost by 75%; in effect one mobilization for every four activities. The results are shown in Table A3-2, where the reduced present worth costs are shown in the lowest row. The resultant changes in ranking are minor.

S&M Costs Variation

Since S&M is viewed primarily as relating to the total area of the PFP site, it has been posited that changes in individual sites do not significantly affect the overall S&M burden. The estimate assumes that most S&M costs continue to apply to Stabilization (Alternative 3) and RTD (Alternative 4). This is because: a) stabilization does not remove much source and b) the RTD alternative excavates to a limited depth. The only variation is a slight reduction in S&M costs for two options of the RTD alternative where the 291-Z building slab is removed. These assumptions are reasonable for stabilization, but could be viewed as penalizing the RTD options by not reducing their S&M substantially.

To test whether this assumption unfairly penalizes RTD, this sensitivity analysis eliminated the S&M cost entirely for all three options of Alternative 4. The results are shown in Table A3-3. As with Sensitivity Case #1, the resultant changes in ranking are minor. The similarity of results in these two cases is a result of the cost reduction being of the same magnitude in both cases.

It should be noted that eliminating S&M for stabilization (not shown), which is not realistic, still results in the Surveillance and Maintenance alternative retaining the highest score.

<u>Importance of Costs Compared with Other Criteria</u>

The third sensitivity case tests two aspects that potentially skew results away from the stabilization and RTD alternatives. These are:

1. The estimate is conservatively high to preclude misperception of the budget required for the selected alternative. This has the effect of lowering the ranking of the stabilization and RTD alternatives relative to the Surveillance and Maintenance alternative.

2. A straightforward inverse of the cost was used for scoring to establish a relationship in which higher cost would produce a lower score. Other more complex methods could be created that might result in smaller differences. The simple method was chosen knowing that it could be tested, as has been done here.

Sensitivity Case #3 drastically reduces the influence of cost by changing the weights (i.e., importance) assigned to the cost criterion to 10% and increasing that of Effectiveness and Implementability criteria to 45%, whereas the base case weights all three equally at 33.3%. The change results in significant change in the relative scores, shown in Table A3-4. Regardless, the Surveillance and Maintenance alternative retains the highest score.

Table A3-1 – Sensitivity Analyses Ranking Summary

Sensitivity Analyses Cases	Alternative 2 (S&M)	Alternative 3 (Stabilization)	Alternative 4 (RTD) Option A (All Slabs)	Alternative 4 (RTD) Option B (Priority Slabs)	Alternative 4 (RTD) Option C (No Slabs)
Base Case (EE/CA Analysis) for Comparison	**31.2**	19.2	14.9	16.0	18.7
#1 Reduced Mobilization/Demob for 3, 4A, 4B, 4C	**30.4**	19.4	15.0	16.2	19.0
#2 No S&M for 4A, 4B, 4C	**30.4**	18.8	14.9	16.2	19.1
#3 Cost Importance Reduced to 10%	**23.3**	16.4	18.3	19.2	22.4

Table A3-2 – Sensitivity Analysis #1; Reduced Mobilization/Demobilization Costs for Alternatives 3 and 4

Sensitivity Analysis #1; Reduced Mobilization/Demobilization Cost by 75%

Overall Criteria	*Weight*	Alternative 1 (No Action)	Alternative 2 (S&M)	Alternative 3 (Stabilization)	Alternative 4 (RTD) Option A (All Slabs)	Alternative 4 (RTD) Option B (Priority Slabs)	Alternative 4 (RTD) Option C (No Slabs)
I. Effectiveness	33%	0.0	2.3	3.5	11.1	8.5	8.0
II. Implementability	33%	0.0	11.1	6.8	2.1	5.3	8.0
III. Cost	33%	0.0	16.9	9.2	1.8	2.4	3.0
	Score	**0.0**	**30.4**	**19.4**	**15.0**	**16.2**	**19.0**

Base Case Cost Summary (Present Worth in $1,000)

Cost Element	Alternative 1 (No Action)	Alternative 2 (S&M)	Alternative 3 (Stabilization)	Alternative 4 (RTD) Option A (All Slabs)	Alternative 4 (RTD) Option B (Priority Slabs)	Alternative 4 (RTD) Option C (No Slabs)
Surveillance and Maintenance	$0	$5,699	$5,699	$5,539	$5,539	$5,699
Capital	$0	$0	$5,519	$54,874	$39,144	$30,527
Sum of Present Worth Costs	**$0**	**$5,699**	**$11,218**	**$60,413**	**$44,683**	**$36,226**

Derivation of Present Worth Cost for Sensitivity Case #1

Cost Element	Alternative 1 (No Action)	Alternative 2 (S&M)	Alternative 3 (Stabilization)	Alternative 4 (RTD) Option A (All Slabs)	Alternative 4 (RTD) Option B (Priority Slabs)	Alternative 4 (RTD) Option C (No Slabs)
Mobilization/Demobilization Cost	$0	$0	$1,024	$8,819	$7,033	$6,189
75%	$0	$0	$768	$6,614	$5,275	$4,642
Reduced Present Worth Costs	**$0**	**$5,699**	**$10,450**	**$53,799**	**$39,408**	**$31,584**

Table A3-3 – Sensitivity Analysis #2; Eliminate S&M Costs for Alternative 4

Sensitivity Analysis #2; Eliminate S&M Costs for Alternatives 4 A, B, C

Overall Criteria	Weight	Alternative 1 (No Action)	Alternative 2 (S&M)	Alternative 3 (Stabilization)	Alternative 4 (RTD) Option A (All Slabs)	Alternative 4 (RTD) Option B (Priority Slabs)	Alternative 4 (RTD) Option C (No Slabs)
I. Effectiveness	33%	0.0	2.3	3.5	11.1	8.5	8.0
II. Implementability	33%	0.0	11.1	6.8	2.1	5.3	8.0
III. Cost	33%	0.0	16.9	8.6	1.8	2.5	3.1
	Score	**0.0**	**30.4**	**18.8**	**14.9**	**16.2**	**19.1**

Base Case Cost Summary (Present Worth in $1,000)

Cost Element	Alternative 1 (No Action)	Alternative 2 (S&M)	Alternative 3 (Stabilization)	Alternative 4 (RTD) Option A (All Slabs)	Alternative 4 (RTD) Option B (Priority Slabs)	Alternative 4 (RTD) Option C (No Slabs)
Surveillance and Maintenance	$0	$5,699	$5,699	$5,539	$5,539	$5,699
Capital	$0	$0	$5,519	$54,874	$39,144	$30,527
Sum of Present Worth Costs	**$0**	**$5,699**	**$11,218**	**$60,413**	**$44,683**	**$36,226**

Derivation of Present Worth Cost for Sensitivity Analysis #2

Cost Element	Alternative 1 (No Action)	Alternative 2 (S&M)	Alternative 3 (Stabilization)	Alternative 4 (RTD) Option A (All Slabs)	Alternative 4 (RTD) Option B (Priority Slabs)	Alternative 4 (RTD) Option C (No Slabs)
Surveillance and Maintenance	$0	$5,699	$5,699			
Capital	$0	$0	$5,519	$54,874	$39,144	$30,527
Reduced Present Worth Costs	**$0**	**$5,699**	**$11,218**	**$54,874**	**$39,144**	**$30,527**

Table A3-4 – Sensitivity Analysis #3; Reduced Importance of Costs

Sensitivity Analysis #3; Reduced Importance of Costs to 10% from 33.3%

Overall Criteria	Weight	Alternative 1 (No Action)	Alternative 2 (S&M)	Alternative 3 (Stabilization)	Alternative 4 (RTD) Option A (All Slabs)	Alternative 4 (RTD) Option B (Priority Slabs)	Alternative 4 (RTD) Option C (No Slabs)
I. Effectiveness	45%	0.0	3.2	4.7	14.9	11.4	10.8
II. Implementability	45%	0.0	15.0	9.2	2.9	7.2	10.7
III. Cost	10%	0.0	5.1	2.6	0.5	0.6	0.8
	Score	**0.0**	**23.3**	**16.4**	**18.3**	**19.2**	**22.4**

Base Case Cost Summary (Present Worth in $1,000)

Cost Element	Alternative 1 (No Action)	Alternative 2 (S&M)	Alternative 3 (Stabilization)	Alternative 4 (RTD) Option A (All Slabs)	Alternative 4 (RTD) Option B (Priority Slabs)	Alternative 4 (RTD) Option C (No Slabs)
Surveillance and Maintenance	$0	$5,699	$5,699	$5,539	$5,539	$5,699
Capital	$0	$0	$5,519	$54,874	$39,144	$30,527
Sum of Present Worth Costs	**$0**	**$5,699**	**$11,218**	**$60,413**	**$44,683**	**$36,226**

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